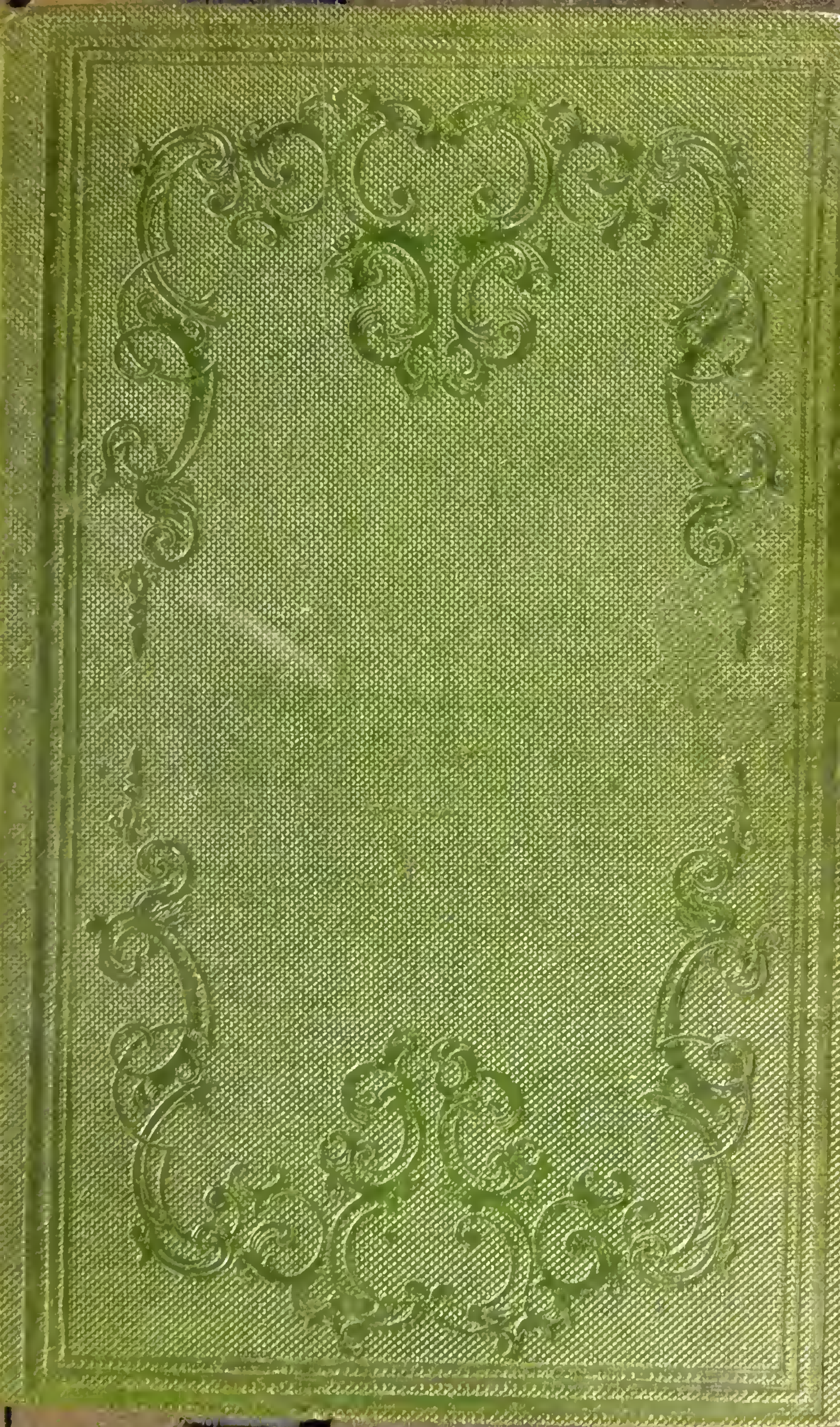

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LESSONS

DERIVED FROM

THE ANIMAL WORLD.

"Ask now the beasts, and they shall teach thee; and the fowls of the air, and they shall tell thee."—Job xii. 7.

SECOND SERIES.

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BEES SWARMING.

THE BEE,

AS AN EXAMPLE OF ECONOMY.

PART I.—THE HIVE-BEE.

THOU cheerful Bee! come, freely come,
   And travel round my woodbine bower;
Delight me with thy wandering hum,
   And rouse me from my musing hour.
Oh! try no more those tedious fields,
Come, taste the sweets my garden yields:
The treasures of each blooming mine,
The bud, the blossom—all are thine.

And, careless of this noontide heat,
   I'll follow as thy ramble guides;
To watch thee pause and chafe thy feet,
   And sweep them o'er thy downy sides:
Then in a flower's bell nestling lie,
And all thy envied ardour ply!
Then o'er the stem, though fair it grow,
With touch rejecting, glance, and go.

O Nature kind! O labourer wise!
   That roam'st along the summer's ray,
Glean'st every bliss thy life supplies,
   And meet'st prepared thy wintry day!
Go, envied, go—with crowded gates
The hive thy rich return awaits;
Bear home thy store, in triumph gay,
And shame each idler of the day.

IN all ages BEES have claimed the admiration of mankind as patterns of industry, economy, cheerfulness, and ingenuity. "Wise in their government, diligent and active in their employments, devoted to their young and to their queen, the Bees read a lecture to mankind that exemplifies their Oriental name Deburah, "*she that speaketh.*"

Our present object in tracing the history of the Bee is to illustrate its ECONOMY—a word of very extensive meaning, derived from the Greek language, in which it signifies the regulation or management of the *house* or of *household* affairs. In this sense the economy of the bee does not simply refer to its disposition to lay up a store of provisions for the support of itself and its young in times of scarcity, but also to the wise and prudent management of its household, by which every member has its appointed duties, to be carried on for the general benefit of the community. And if it can be shown that the bee is an illustrious example of this comprehensive economy, a knowledge of its history may be an incentive to us in the practice of this admirable virtue.

And even if we limit the meaning of the word economy to a disposition to save, much will be found to admire in the judicious exercise of it. There can be no saving without previous industry, and industry produces cheerfulness, and cheerfulness health. "A bee amongst the flowers of spring," says Paley, "is one of the cheerfulest objects that can be looked upon. Its life appears to be all enjoyment; so busy and so pleased." And this disposition to save is altogether removed from selfishness. The bee makes a profitable use of its pastures, but leaves enough for the tenants of a neighbouring hive; or, as the poet beautifully expresses it:—

Bees work for man; and yet they never bruise
Their master's flower, but leave it, having done,
As fair as ever, and as fit to use:
So both the flower doth stay, and honey run.*

Those who inhabit the human hive are most happy who understand best the economy we have been speaking of. They study economy of time, of food, of clothes, and of every description of property, and they feel that to waste any of these is sinful. They regard the various blessings of life not as their own property, because "the earth is the Lord's and the fulness thereof," but as talents committed to their charge to be improved and accounted for. Such persons are not selfish—it is only shallow thinkers who call them so; they accumulate property, it is true, but with it they increase their means of doing good, for it is obviously those who know the value of property that can lay it out to the best advantage either for themselves or for others.

Many a poor man would be happy and prosperous if he had only the disposition to save. A man with a small income, whose wants are equal to his earnings, will always remain poor; while one whose income is more than sufficient for his wants becomes rich, since every man may be called rich who has more than he requires to spend. Many a man thinks he will save when his circumstances improve, but should this ever happen, he usually finds his wants increase in the same proportion; he must live better, wear finer clothes, have more frequent holidays, and so his ability to save, as well as the disposition, is as far off as ever. A sudden illness comes upon him, or he is thrown out of work, and then he and his family are reduced to want, and the opportunity of saving, once lost, never comes to him again.

---

* George Herbert. Poem on Providence.

In saving, as in every thing else, the difficulty is to make a beginning. Many men suppose that the small trifle they are able to spare at any one time is not worth saving. If the bee reasoned after this fashion there would be but little storing of honey; whereas, by adding drop to drop the industrious workers of a hive manage to collect eighty or a hundred pounds weight of honey in a single season. If a man, determined to save, were to put by a sum, however small, the very next time he did so he would exactly double it; and if he made use of that excellent institution the Savings Bank, his money would not only be in safe keeping, but at the end of every year would be increased by a small sum, in the way of interest, for which he had not worked.

The history of the bee furnishes a wonderful example of what can be done by means of small savings. Some years ago it was calculated that in one year the island of Cuba exported honey and wax to the value of upwards of 130,000*l.* sterling; and it has been calculated that if bees were more generally kept in this country, the pastures of Scotland alone could maintain as many bees as would produce four million pints of honey, and one million pounds weight of wax; and were these quantities tripled for England and Ireland, the produce of the

British empire would be twelve million pints of honey and three million pounds of wax per annum; and allowing 2*s*. 6*d*. per pint for the honey, and 1*s*. 6*d*. per pound for the wax, we have an annual produce in money of 1,725,000*l*. sterling, with scarcely any outlay either of capital or time.

These wonderful results proceed from small savings, and perhaps some readers will be surprised to learn that the Savings Banks of this country, up to the 20th November, 1844, had collected no less a sum than 31,275,636*l*., the property of 1,012,475 *working bees*, as we may truly call the poor men, mechanics, and servants, whose shillings had helped to raise this enormous sum.

If we divide this sum by the number of depositors, it will be found that each depositor is the owner of about 30*l*. Now we need not stop to point out the immense advantage of such a sum to a poor man;—how that with it he might join some Friendly Society, which would support him in his old age; or how he might give his children a good education, or apprentice them out to some trade; or how he might even set himself up in some business: all this he knows, but perhaps he does not remember that the working man who never saves must always be a working man; he can never go into business on his own account, he can never pay wages to another, because wages are paid out of capital which has been accumulated by saving.

If a man has no capital, he cannot properly enjoy that honest independence which is the birthright of every Englishman; if he is out of work, he is compelled to take the first place that offers; he cannot afford to remain out of employment a week or two to look about him and choose for himself; if he is a mechanic he cannot travel to other places to improve himself in his trade; he must remain fixed to one spot, working hard for his week's wages, and spending them perhaps before they are earned, for a man who has no disposition to save can scarcely avoid running into debt.

If much may be done with a small capital, what wonders do we see every year being produced by large capital, which, after all, is made up of small savings. By means of capital, barren lands are brought into cultivation, roads, railroads, bridges, houses, and factories are built, and thousands of persons employed, none of which could be done unless some persons had practised the virtue of economy.

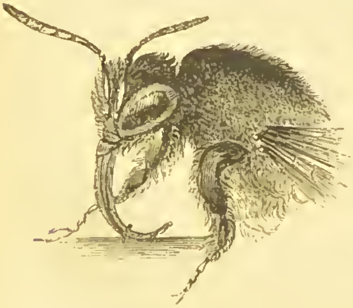
If the bees consumed every day the honey which they made, of what use would they be to us? We should no longer respect and value them, as we do now. We should turn them out of our gardens just as they turn out the drones, as so many useless mouths which save nothing, but only reduce the general stock. The same disposition is observed in society towards those who spend all their earnings upon themselves; when they can work no more the honey is given with a grudging hand, the poor drone feels the hardness of his lot and laments his folly when it is too late. Let us, then, take courage by the example of the bee,—let us "improve each shining hour," remembering that "the soul of the sluggard desireth and hath nothing, but the soul of the diligent shall be made fat," Prov. xiii. 4.

The Honey Bee (*Apis mellifica*) belongs to the same order as the Ants, namely, *Hymenoptera*, or that of insects with four membranaceous wings. In its wild state it builds in the hollows of trees, or indeed in any natural cavity. In the summer of 1846 a swarm of bees alighted on the head of one of the ornamental lions in front of Viscount O'Neill's residence, Thane's Castle, in Ireland, and proceeding down the mouth of the figure, established themselves in the spacious cavity. Bees have even been known to take possession of the dried carcasses of animals, as is mentioned in Judges xiv. 8, 9; whence, probably, arose the idea entertained by the ancients, that they are produced from the putrid bodies of oxen and lions.

A colony of bees occupying a hive consists, besides the young brood, of one female or *queen*, several hundreds of males or *drones*, and many thousand *workers*.

WORKER.

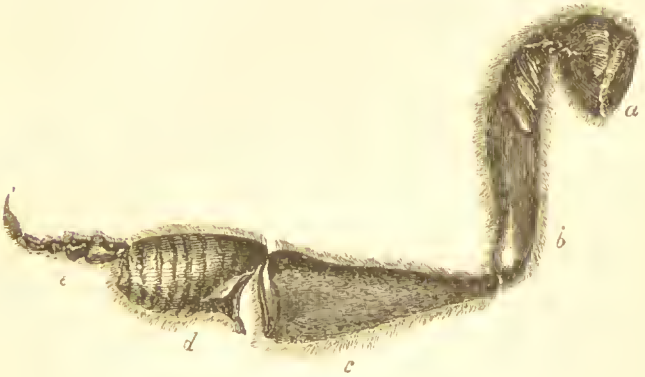
The appearance of the worker is probably known to most persons; it will therefore only be necessary to mention a few admirable contrivances in the structure of the insect. Its body is about half an inch long, of a dark brown colour, which deepens with age, and is covered with close set hairs which assist greatly in collecting the farina of flowers. These hairs are shaped like feathers, each consisting of a stem with branches disposed around it. The head of the bee is of a flattened triangular shape, furnished with a pair of large eyes, consisting of a vast number of small hexagonal surfaces, each of which is a perfect eye; there are also three small eyes in the crown of the head, arranged in the form of a triangle. The antennæ, which spring from between the eyes, are extremely flexible; they seem to be organs of touch of exquisite sensibility. The mouth of the bee is furnished on the lower lip with a proboscis, which appears to be almost as beautiful in its structure as that of the elephant; from the base of the proboscis proceed *feelers*, by means of which the insect ascertains the nature of its food. The upper jaw, as is the case with all insects, is divided into two parts called *mandibles*; they are furnished with teeth, and have a horizontal movement; with this instrument the workers execute much of their work, as will be noticed hereafter. The bee is furnished with two pairs of wings, of unequal size, behind which on each side are several small orifices called *stigmata*, through which the breathing is carried on. These orifices are connected with air-vessels in every part of the body, and the rushing of the air through them



HEAD OF BEE.

against the moving wings is supposed to be the cause of the humming sound made by bees.

The bee is furnished with three pairs of legs: the front pair, which are the shortest, are almost as useful as hands and arms to man. The hinder legs are the longest, and in these is an admirable provision for enabling the worker to carry an important part of its stores to the hive. The shin, or middle portion of each of the hind pair of legs, is formed into a kind of basket of a triangular shape: the bottom of this basket is composed of a smooth, horn-like material, hollowed out in the substance of the limb and surrounded with strong thickly-set hairs. In this basket is collected the *pollen* of flowers, one of the ingredients composing the food of the young; and also the *propolis*, a viscous sub-



HIND LEG OF WORKER.

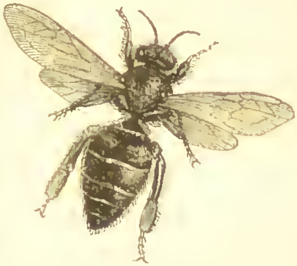
a, the haunch, *b*, the thigh; *c*, the tibia, or pallet, containing the basket or cavity; *d*, *e*, the foot.

stance by which the combs are attached to the roof and walls of the hive, and by which any openings are stopped that might admit vermin or the cold. The three pairs of legs are all furnished with thickly-set hairs forming brushes, which serve the purpose of sweeping off the farina. The extremities of the six feet terminate each in two hooks, with their points opposed to each other, by means of which the bees fix themselves to the roof of the hive and to one another, when suspended, as they often are, in the form of festoons, curtains, &c.

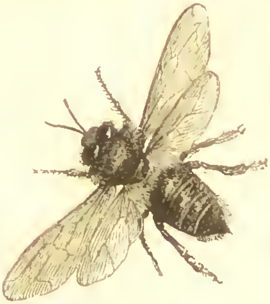
The worker bee has two stomachs; the first, called the *honey-bag*, is, when full, a small transparent globe about the size of a pea: the bee can contract it so as to turn out its contents into cells appropriated to the storing of honey. The second stomach is only a short tube in which food is digested, and the honey received which is intended to be formed into wax, as will presently be noticed. The sting with its appendages lies close to the stomach. It consists of two darts of unequal length, enclosed in one sheath, along a groove in which, after the darts have inflicted the wound, flows the poison from a bag in the body of the insect. The darts are furnished with barbs or teeth, by which they are retained in the wound till the poison is injected. It is said that the insect is able to raise or depress these barbs at pleasure, but it often happens that on being suddenly driven away the insect leaves its sting behind, mutilating itself so seriously that death is the consequence.

The QUEEN, or, as she is more properly called by

Continental writers, the *Mother-Bee*, differs in many particulars from the workers. Her body is much larger and of a deeper colour; her proboscis is more slender; her legs are longer and without the hairy brushes at the joints, nor are the hind legs furnished with the basket which is noticed in the workers. The queen is furnished with an ovarium containing a large assemblage of vessels filled with eggs. Her sting is bent, while that of the worker is straight.

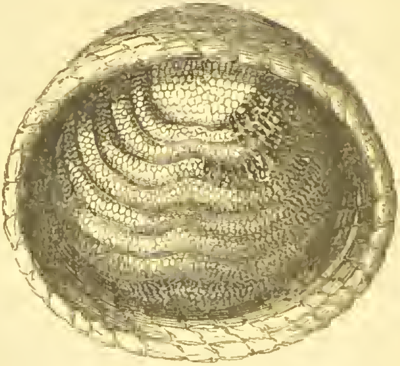

THE QUEEN, OR MOTHER BEE.

The male, or *drone*, so called from the loud humming noise which he makes in flying, is much larger than the working bee; his eyes are more prominent; the proboscis is shorter; the farina basket in the hind legs is absent, and he has no sting.


THE MALE, OR DRONE.

Having made acquaintance with the colonists, let us examine the colony and the various works which are carried on therein, taking as our principal guides the observations of the elder Huber, and the excellent descriptions of Messrs. Kirby and Spence.

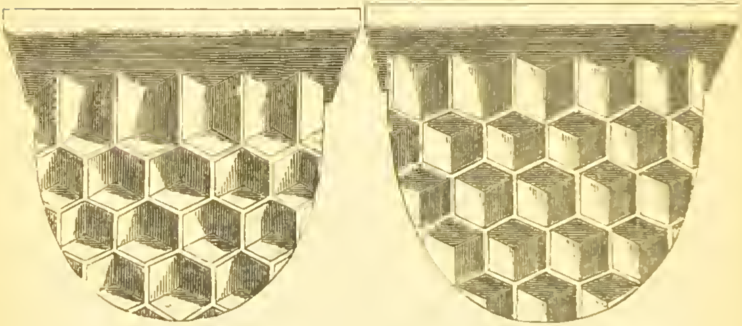
"The most profound philosopher, equally with the most incurious of mortals, is struck with astonishment on inspecting the interior of a bee-hive. He beholds a city in miniature. He sees this city divided into regular streets, these streets composed of houses constructed on the most exact geometrical principles, and the most symmetrical plan, some serving for store-houses for food, others for the habitations of the citizens, and a few, much more extensive than the rest, destined for the palaces of the sovereign. He perceives that the substance of which the whole city is built, is one which man, with all his skill, is unable to fabricate; and that the edifices in which it is employed are such as the most expert artist would find himself incompetent to erect. And the whole is the work of a society of insects!"



INTERIOR OF THE HIVE.

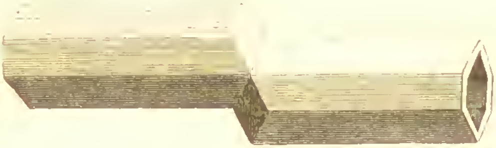
Whether the hive be a natural or an artificial cavity, the general plan is the same. A number of honey-combs, composed of cells for the most part *hexagonal* or *six-sided*, regularly applied to each other's sides, and arranged in two strata or layers placed end to end, are fixed to the upper part and sides of the interior of the hive. These combs are arranged vertically at a small distance from each other, so that the cells composing them are placed in a horizontal position, and have their openings in opposite directions. The distance of the combs from each other is about half an inch, sufficient to allow two bees to pass each other easily. Besides these vacancies the combs are here and there pierced with holes, which serve as a means of communication from one comb to another, without losing time by going round.

The cells being formed of wax, a substance secreted by the bees in no great abundance, it is important that as little as possible should be consumed. Bees, therefore, in the formation of their cells have to solve a problem in geometry, namely, "a quantity of wax being given, to form of it similar and equal cells of a determinate capacity, but of the largest size in proportion to the quantity of matter employed, and disposed in such a manner as to occupy in the hive the least possible space." Every part of this problem is practically solved by bees. If their cells had been cylindrical, which form seems best adapted to the shape of a bee, they could not have been applied to each other without leaving a number of useless vacant spaces. If the cells were made square or triangular, this last objection would be removed; but besides that a greater quantity of wax would have been required, the shape would have been inconvenient to a round-bodied animal. All these difficulties are obviated by the adoption of hexagonal cells, which are admirably fitted to the form of the insect, at the same time that their sides apply to each other without the smallest vacant intervals. Another important saving in materials is gained by making a common base serve for two strata of cells. Much more wax as well as room would have been required, had the combs consisted of a single stratum only. But this is not all. The base of each cell is not an exact plane, but is usually composed of three lozenge-shaped pieces, placed so as to form a pyramidal concavity. From this form it follows that the base of a cell on one side or stratum of the comb is composed of portions of the bases of *three* cells on the other. The advantage of this arrangement is, First, a greater degree of strength; and secondly, precisely the same as results from the hexagonal sides—a greater capacity with less expenditure of wax. This has been clearly proved, as also that the angles of the base of the cell are exactly those which require the smallest quantity of wax. It is obvious that these angles might vary



FRONT AND REVERSE VIEW OF CELLS.

infinitely; but by a very accurate measurement Maraldi found that the great angles were in general 109° 28′, the smaller ones 70° 32′. Réaumur, suspecting that the object of choosing these angles was to spare wax, proposed to M. König, a skilful geometrician, to determine by calculation what ought to be the angle of a hexagonal cell, with a pyramidal bottom, formed of three similar and equal rhomboid plates, so that the least possible matter might enter into its construction. After an elaborate calculation, the geometrician found that the great angles of the rhombs should be 109° 26′, and of the small angles, 70° 34′, a surprising agreement between the solution of the problem and the actual measurement.

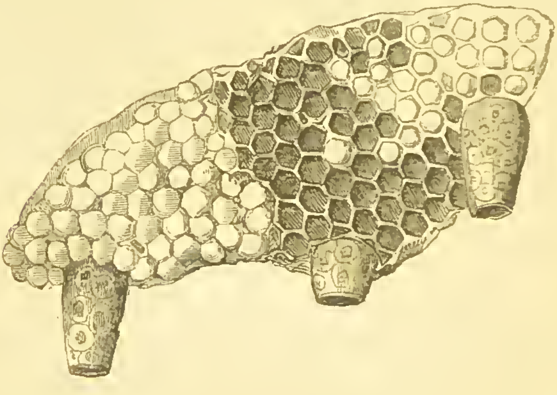


METHOD OF JOINING CELLS

The bees have also another contrivance for saving wax. They form the bottoms and sides of the cells of wax not thicker than writing paper; but as walls of this thinness at the entrance would be perpetually injured by the going in and out of the workers, they make the margin at the opening of each cell three or four times thicker than the walls.

The cells are made of different sizes according to their use. Those which are to contain the larvæ of the males are considerably larger than those intended for the workers.

The abode of the larvæ of the queen bee differs still more. It is not only much larger than any of the rest, but altogether different in form, being shaped like a pear or a Florence flask, and composed of a coarser material than common wax, of which above one hundred times as much is used in its construction as of pure wax in that of a common cell. The situation of these cells (of which there are several in each hive) is also different from that of the common cells. Instead of being in a horizontal, they are placed in a vertical direction, with the mouth downwards, and are usually fixed to the lower edge of the combs. The cells used for storing honey and pollen are deeper and more capacious than those which the larvæ of the males and workers inhabit. When honey is abundant, and there is not time to construct fresh cells, the bees lengthen the honey cells by adding a rim to them.


HONEYCOMB, WITH MALE, WORKER, AND ROYAL CELLS.

Before the bees begin to build their cells, they collect a brown resinous substance, furnished by the poplar, the birch, and the willow, called *propolis*,* which they use for cementing and varnishing the hive, for by means of it the combs are attached more firmly to the foundation than could be effected by wax alone, which is neither so tenacious nor acquires so great a degree of hardness. Mr. Knight succeeded in forming an artificial propolis of bees' wax and turpentine, which he applied to that part of the trunk of a tree from which he had stripped the bark. Some hive-bees, finding this a very good propolis ready made, detached it from the tree with their mandibles, and then as usual passed it from the first leg to the second, and then to the little basket in the third. When one bee had thus collected its load, another often came behind and took it away; a second and a third load were frequently lost in the same manner, while the patient insect pursued its operations as before. This was probably one of the many instances of the division of labour for which bees are so remarkable.

In collecting propolis, the bee first kneads the piece she has detached with her mandibles till it becomes somewhat dry and less adhesive, as otherwise it would stick to her limbs. This sometimes occupies nearly half an hour. She then passes it to her basket, giving it two or three pats to make it adhere, and on adding a second portion she pats it still harder. When the basket is full she flies off with it to the hive. Some of the ingenious applications of propolis in the hive will be noticed further on.

---

* From two Greek words signifying *before the city*, as the substance is principally applied to the projecting parts of the hive.

The processes by which the cells are constructed were discovered and explained by Huber, the father of the talented observer whose discoveries will be noticed in the history of the Ant. But the most astonishing circumstance connected with the elder Huber is that *he was blind!* and made all his beautiful discoveries by using the eyes of others.*

It was discovered by Huber that the workers or neuters of a hive consist of two descriptions of individuals, namely, *nurse-bees*, and *wax-makers.* The nurse-bees are smaller in size than the wax-makers; and their office is to build the combs and cells after the foundation has been laid by the wax-makers, to collect honey, and to feed the larvæ. The nurse-bees are not altogether incapable of forming wax, but the quantity produced by them is quite insignificant.

Wax is a real animal secretion, and is formed or secreted by the wax-makers in four pairs of membranous bags, contained in the abdomen, called *wax-pockets.* It is secreted by some unknown process from the food taken into the stomach, which in the wax-makers is much larger than in the nurses, and it afterwards oozes through the membrane of the wax-pocket and forms into thin plates. When wax is not wanted in the hive, the wax-makers empty their honey into the cells.

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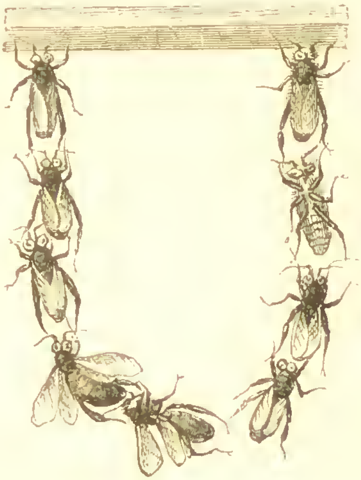
* During forty years his wife never ceased to bestow upon him the most affectionate attention; she was his reader, his secretary, and his observer. "As long as she lived," said Huber, "I was not sensible of the misfortune of being blind." He also had a servant named Francis Burnens, remarkable for his sagacity, and for his devotion to his master. Huber practised him in the difficult art of observation, directed him to his researches by questions skilfully combined, and aided by the recollections of his youth (for he did not become blind till the age of seventeen) and by the testimonials of his wife and friends, he rectified the statements of his assistant, and was enabled to form in his own mind a perfect image of the minutest facts. In his later researches he was assisted by his son, who, under the guidance of such a father, became at an early age an accomplished naturalist.


FESTOON OF WAX-MAKERS.

The processes of wax-making and building the combs in a bee-hive, are conducted as follows: —The wax-makers having taken a quantity of honey or sugar into the stomach, suspend themselves to each other, the claws of the fore legs of the lowermost being attached to those of the hind pair of the uppermost, and thus form a cluster, the exterior layer of which looks like a curtain. This cluster consists of a series of festoons or garlands, which cross each other in all directions, and in which most of the bees turn their back upon the observer. The curtain has no other motion than what it receives from the interior layers. The wax-makers themselves remain immovable for about twenty-four hours, during which period the secretion of wax takes place. One of them is then seen to detach itself from one of the central garlands of the cluster, and to make a way amongst its companions to the top of the hive, where it turns itself round, and clears a space of about an inch in diameter. It then seizes one of the plates of wax with a pincer, formed at the joints of the leg, and drawing it out of the pocket, carries it forward to its mouth with the claws of the fore legs. The mandibles soon reduce the plate to a riband of wax, which the proboscis impregnates with a frothy liquor. During this operation the proboscis assumes a variety of forms; sometimes it is flattened like a spatula, then like a trowel, at other times it is like a pencil, terminating in a point. After having moistened the whole of the riband, the proboscis pushes it, so as to make it re-enter the mandibles, but in an opposite direction, where it is worked up anew. The liquor mixed with the wax gives it a whiteness and an opacity which it had not before, the object being to impart to it that ductility and tenacity which it possesses in its perfect state.

THE PROBOSCIS.

The parcels of wax thus prepared are applied against the vault of the hive, the little builder arranging them with the point of her mandibles in the direction which she wishes them to take; and she continues these operations until she has employed the whole plate that she had separated from her body, when she takes a second, and proceeds in the same manner. She gives herself no care to compress the particles of wax which she has heaped together; she is satisfied if they stick together. At length she leaves her work, and is lost in the crowd of her companions. Another succeeds, and resumes the employment; then a third; all follow the same plan of placing their little masses; and if one by chance gives them a contrary direction, another, coming after, removes them to their proper place. The result of all these operations is a little wall of wax, with uneven surfaces, five or six lines* long, two lines high, and half a line thick, which descends perpendicularly from the vault of the hive. In this first work there is no angle, or any trace of the figure of the cells. It is a simple partition, in a right line, without any bend.

LAYING FOUNDATION OF CELL.

The wax-makers having thus laid the foundation of a comb, the nurse-bees come to model and complete the work. The former are the labourers, who convey the materials; the latter, the artists, who work them up into the form which the intended structure requires. One of the nurse-bees places herself horizontally on the vault of the hive, her head corresponding to the centre of the wall which the wax-makers have left, and which is to form the partition of the comb into two opposite assemblages of cells ; and with her mandibles, rapidly moving her head, she moulds a cavity which is to form the base of one of the cells. When she has worked some minutes, she departs, and another takes her place, deepening the cavity, heightening its lateral margins by heaping up the wax to the right and left, by means of the teeth and fore feet, and giving them a more upright form. More than twenty bees successively employ themselves in this work. When arrived at a certain point, other bees begin on the yet untouched and opposite side of the mass, and commencing the bottom of *two* cells, are in turn relieved by others. While still engaged in this labour, the wax-makers return, and add to the mass, increasing its extent every way, the nurse-bees again continuing their operations. After having worked the bottoms of the cells of the first row into their proper forms, they polish them, and give them finish, while others begin the outline of a new series.

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* A line is the twelfth part of an inch.

COMMENCEMENT OF CELLS.

The cells, themselves, consisting of six-sided tubes, are next constructed. These are engrafted on the borders of the pyramidal cavities, hollowed out as above described. The bees commence by making the edges of the cavities, or bottoms, which at first are unequal, of equal height. Thus all the margins of the cells offer an uniformly level surface from their first origin, and until they have acquired their proper length. The sides are heightened in an order similar to that which the insects follow in finishing the bottoms of the cells ; and the length of these tubes is so perfectly proportioned, that there is no observable inequality between them. It is to be remarked, that though the general form of the cells is hexagonal, or six-sided, that of those first begun is an irregular pentagon, the side next the top of the hive, and by which the comb is attached, being much broader than the rest ; whence the comb is more strongly united to the hive than if these cells were of the ordinary shape.

The form of a new comb is that of a lens, its thickness always diminishing towards the edges. This gradation is constantly observable, whilst it keeps enlarging in circumference ; but as soon as the bees get sufficient space to lengthen it, it begins to lose this form, and to assume parallel surfaces ; it has then received the shape which it will always preserve.

The bees appear to give the proper forms to the bottoms of the cells by means of their antennæ, which extraordinary organs they seem to employ as directors, by which their other instruments are instructed to execute a very complex work. They do not remove a single particle of wax until the antennæ have explored the surface that is to be sculptured. By the use of these organs, which are so flexible, and so readily applied to all parts, however delicate, that they can perform the functions of compasses in measuring very minute objects, they can work in the dark, and raise their wonderful combs.

All these proceedings are conducted with the utmost regularity. The original mass of wax is increased in a uniform quantity by the wax-makers, who merely produce and carry the materials, but have not the art of sculpturing the cells. Two masses of wax for combs are never begun at the same time; but no sooner are some rows of cells constructed in the first mass, than two other masses, one on each side of it, are established at equal distanees from it, and parallel to it, and then again two more exterior to these. In a new hive the bees work with such rapidity, that in twenty-four hours they will sometimes construct a comb twenty inches long by seven or eight inches wide, and the hive will be half filled in five or six days; so that in the first fifteen days as much wax is made, as in the whole year besides.

The cells intended for the larvæ of workers are always $2\frac{2}{5}$ lines in width; those meant for the larvæ of the males or drones are $3\frac{1}{3}$ lines wide. The male cells are generally in the middle of the combs, or in their sides, but rarely in their upper part. When the bees form male cells below those of workers, they construct many rows of intermediate ones, the width of which increases gradually till it equals that of a male cell. The kind of eggs which the queen is about to lay determines the kind of cells that are to be made: while she lays the eggs of workers, no male cells are constructed; but when she is about to lay the eggs of males, the workers appear to know it, and act accordingly. When honey is abundant, the bees increase the width and length of their cells from 12 to 15 and even 18 lines in length.

The position, and even the form of the combs, are subject to considerable variation, according to circumstances. Indeed, the works of bees are symmetrical, less, perhaps, in minute details, than considered as a whole. Our variable climate occasions frequent interruptions, and injures the symmetry of the combs; for a work resumed is always

ANOTHER INTERIOR OF A BEE-HIVE.

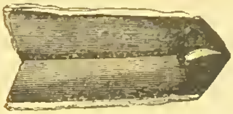
less perfect than one followed up until completed. The cells are seldom perfectly horizontal; they are almost always a little higher towards their mouth than at their base.

The wax-makers having secreted, and cut up and kneaded the wax, are dismissed from their labour, and fly off to the fields, to regale themselves with food. But as the moulding of the cells involves considerable time and labour, and the nurses are not allowed to leave their work, they frequently need refreshment, which is supplied by a third set of workers. When one of the nurses feels disposed for food, she bends down her proboscis before the caterer, who immediately opens his bag of honey, and pours out a drop, which the nurse takes, and then returns to her work as before.

When the cells are entirely finished, as far as wax is concerned, they are further strengthened by means of propolis. Huber noticed the method of doing this :—One of the bees having approached a heap of propolis, drew out a thread with its teeth. This being broken off, it was taken in the claws of the fore-feet, and the bee, re-entering the cell, immediately placed it in the angle of two portions that had been smoothed; in which operation the fore-feet and teeth were used alternately; but the thread, being probably too clumsy, was reduced and polished, and accurately fitted. The insect then prepared other parts of the cell for receiving a second thread, using for the purpose the portion of the thread cut off on the former occasion ; giving it all the solidity and finish of which it was susceptible. Other bees concluded the work which the first had begun, and the sides of the cells were speedily secured with threads of propolis, while some were also put on the orifices.

It has been already noticed, that, by means of propolis, the bees stop up all the little crevices which might admit the winter's cold: with this substance they also fasten the hive to the floor, to prevent its being blown over by the wind; and they also employ it to keep out their enemies. By means of propolis the bees contract the entrance to the hive, and erect walls or barricades within it to keep out their dangerous enemy, the death's-head hawk-moth. But it sometimes happens that a slug, lured by the agreeable odour, finds its way into the hive; it is soon attacked, and stung to death: but such a burden is too heavy for the bees to remove, and the smell arising from its putrefaction would be mischievous. They therefore embalm it with propolis, through which no effluvia can escape. A snail found its way into one of Réaumur's hives, and was disposed of with much less trouble and expense to the bees. The first sting naturally caused it to retire within its shell; the bees then glued all round the margin of the shell, and left the animal fixed without the least power of motion.

The first cells that are formed are the nurseries of the young brood. As soon as they are ready they are visited by the queen, who deposits a single egg in each. In doing this, she first puts her head into a cell, as if to ascertain that it is in a fit state for her purpose. Then withdrawing her head, she curves her body downwards, inserts her abdomen into the cell, and turns half round upon herself: she remains in this position for a few seconds, during which she lays an egg, of a slender oval shape, slightly curved, rather more pointed in the lower end than in the other; this egg is attached to the bottom of the cell by a glutinous matter which covers it, and which dries immediately. In this way the queen passes on from cell to cell, depositing an egg in each. She is always attended by a body-guard of workers, who clear the way for her, bestow upon her the most affectionate attentions, and supply her with food: they always turn their heads towards her; and, as she passes along, the workers suspend their labours to pay her homage, but resume them when she has moved on. It is stated by Mr. Duncan, in the "Naturalist's Library," that when the queen has laid about thirty or forty eggs on one side of the comb, instead of laying in all the empty cells in the same quarter, she removes to the other side, and lays in the cells which are directly opposite to those which she has just supplied with eggs, and, generally speaking, in none else. "This mode of proceeding is of a piece with that wise arrangement which runs through all the operations of the bees, and is another effect of that remarkable instinct by which they are guided. For as they cluster closely in those parts of the comb which are filled with brood, in order to concentrate the heat necessary for their being hatched, the heat will of course penetrate to the other side; and some portion of it would be wasted, if the cells on that side were either empty, or filled only with honey. But when


EGG IN CELL.

both sides are filled with brood, and covered with hive-bees, the heat is confined to the spot where it is necessary, and is turned to full account in bringing the young to maturity."

The impatience of the queen to lay eggs is very remarkable. No sooner are a few square inches of comb constructed, and even before the cells are quite completed, she begins to deposit her eggs, and continues to do so throughout the season, at the rate of between one and two hundred a-day, unless cold weather should retard the hatching of the eggs already laid. It has been calculated that the queen produces, in one season, the surprising number of one hundred thousand eggs. A population of two or three thousand at the beginning of the year will so far have increased their numbers as to be able, in June, to throw off swarms amounting to forty or fifty thousand, and still retain in the autumn a population of about twenty thousand.

After an egg is deposited in one of the cells, it remains three days; on the fourth day the shell is burst, and a small lively worm appears. The nurse-bees immediately minister to its wants, supplying it abundantly with food composed of the pollen of flowers, which in the infancy of the colony the workers are constantly employed in gathering and storing in the hive, where it is converted into a sort of whitish jelly called *bee-bread*, by being received into the bee's stomach, where it is probably mixed with honey, and thrown up again. With this bee-bread the young brood are diligently fed by the nurses, who anxiously attend upon them, and several times a-day afford a fresh supply. Different bees are seen successively to introduce their heads into the cells containing them, and after remaining in that position some moments, during which they replace the expended provision, pass on to those in the neighbourhood. Others often immediately succeed, and in like manner put in their heads, as if to see that the young ones have everything necessary, which being ascertained by a glance, they immediately proceed, and stop only when they find a cell almost exhausted of food. That the office of these purveyors is no very simple affair will be admitted when it is understood that the food of all the grubs is not the same, but that it varies according to their age, being insipid when they are young, and more sugary and somewhat acid when they have attained maturity.

The appearance of the grub as soon as it is hatched, is that of a small straight worm; it grows rapidly, and soon touches the sides of its cell, when it contracts its body and coils itself up, continuing to increase in size until the extremities meet and form a complete ring. In this state it continues to consume the bee-bread, with which the nurses supply it during five days, after which it ceases to eat; the nurses then seal up the cells with a lid of wax, convex in those containing the larvæ of drones, and nearly flat in those containing the larvæ

GRUB IN CELL.

of workers, beneath which the enclosed nurseling spins in security its cocoon. In all these labours neither the queen nor the drones give any assistance. They are performed entirely by the workers, who, constantly called upon to minister to the wants of fresh broods, as those brought to maturity are disposed of, pass nearly the whole of their existence in fulfilling these duties. "It is impossible to describe the care which the workers bestow on their young charge, towards whom they seem to cherish the tenderest attachment. A comb filled with brood, and placed in an empty hive, never fails to retain them there, to the utter disregard of the loss of their stores. The tenderest mother could not watch over her children with more affection, nor supply them with nourishment more impartially or in greater abundance. At the same time it is done without waste, for the quantity is so proportioned to the demand, that none of it remains in the cells when the larvæ undergo their transformation to the nymph state."

The silken film which the larva spins round its body proceeds from the middle part of the under lip, and is composed of two threads gummed together as they issue from the two orifices of the spinner. The larva is occupied thirty-six hours in forming its cocoon; three days after which it becomes a *nymph* or *pupa*, previous to its assuming the *imago*, or perfect insect form. While this change is going on, the temperature of the hive is raised by an extraordinary process. A number of nurse-

NYMPH, OR PUPA.

bees are employed to impart warmth from their bodies to the young bees in the cells, by brooding over them. Each nurse fixes itself upon the cell of the nymph, and begins at first to respire very gradually; in a short time its respirations become more and more rapid, until it sometimes respires at the rate of one hundred and twenty or one hundred and thirty in a minute; this is continued for eight or ten hours, at the end of which time its body has become of a very high temperature, and the insect is in a state of great perspiration; the nurse then generally discontinues her office for a time, and another individual will sometimes take her place.* During this process the cocoon gradually becomes attached to the interior of the cell, like a lining, and the bee having all its parts gradually unfolded, begins on the twentieth day from the time of laying the egg, to cut through with its mandibles the cover of its cell. In escaping from its cradle it does not, like the ants, require the assistance of the workers, but by its own efforts succeeds in about half an hour in eating its way out of the cell; it then rests for a short time, as if exhausted with the effort, but on the very same day, as soon as it is able to use its wings, seems perfectly aware, without any previous instruction, what are to be its duties and employments for the rest of its life. "It appears to know that it is born for society, and not for selfish pursuits; and, therefore, it invariably devotes itself and its labours to the benefit of the community to which it belongs. Walking upon the combs, it seeks for the door of the hive, that it may sally forth to be useful. Full of life and activity it then takes its first flight, and, uneducated but by its instinct, visits like the rest the subjects of Flora, absorbs their nectar, covers itself with their ambrosial dust, which it kneads into a mass and packs upon its hind legs, and, if need be, gathers propolis, and returns unembarrassed to its own hive."

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* This subject will be further noticed in Part II.

As soon as the young bee has quitted the cell, the workers clean it out, remove the fragments of the cover, strengthen the entrance with a new bordering of wax, and thus prepare it for the reception of another egg, or of honey or farina. They do not disturb the remains of the silken cocoon, which the late tenant had left lining the cell; consequently, it happens that as every succeeding tenant leaves a similar lining the cell becomes in time much reduced in size. These linings may be removed one by one by soaking the comb in water; sometimes as many as seven or eight may be taken out of one cell, thus indicating the number of bees to which it has been the birthplace.

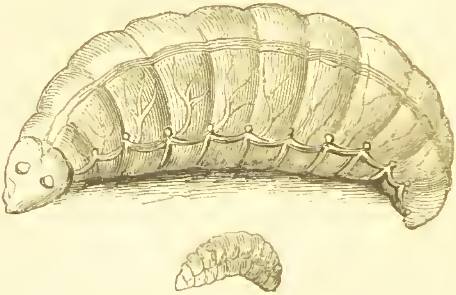
During the first few months the queen lays workers' eggs only, and she begins to do so in February and sometimes as early as January. After this, in the spring, male eggs are laid during thirty days; in which time about two thousand are produced. Another, and less considerable laying of them takes place in autumn. The eggs of males, like those of common bees, are hatched in three days; the larva state continues six and a half days, instead of five, and having formed their cocoon, and been changed into nymphs, they attain the perfect insect state on the twenty-fourth day.

The male, or drone, is the father of the hive, and his life is short and indolent. He takes no part in the labours of the hive, and ventures out only in the finest weather, and during the warmest part of the day, when the young queens are out. His large size, heavy flight, and loud hum, easily distinguish him from the workers. The drones do not live, or rather are not allowed to live, more than two or three months; the eggs that produce them being laid in the course of April and May, and they are usually put to death in July and August; the object of this extermination seems to be to get rid of the idle part of the population, which having no further office to perform in the hive, would prove a useless burden to the rest of the community. The details of this carnage are given by Huber, who noticed that the workers chased away the drones from the provision cells to the bottom of the hive, where, being weakened by hunger, they fell easy victims to the thrift of their superiors. In order to watch the proceedings, Huber placed six hives upon a glass table, under which his faithful observer, Burnens, stationed himself, thus obtaining a good view of the interior. "On the 4th of July," he says, "we saw the workers actually massacre the males in the whole six swarms, at the same hour and with the same peculiarities. The glass table was covered with bees, full of animation, rushing upon the drones as they came from the bottom of the hive; they seized them by the antennæ, the limbs, and the wings, and, after having dragged them about, or, so to speak, after quartering them, they killed them by repeated stings directed between the rings of the belly; the moment that this formidable weapon reached them was the last of their existence—they stretched their wings and expired. At the same time, as if the workers did not consider them as dead as they appeared to be to us, they still darted it so deep that it could hardly be withdrawn, and they were obliged to turn round upon themselves before the stings could be disengaged.

"Next day, having resumed our former position, we witnessed new scenes of carnage. During three hours the bees furiously destroyed the males; they had massacred all their own on the preceding evening, but now they attacked those which, driven from the neighbouring hives, had taken refuge amongst them. We saw them also tear some remaining nymphs of this species from the combs; they greedily sucked all the fluid from the abdomen, and then carried them away;—the following day no drones remained in the hives."

A remarkable exception to this periodical massacre of the drones takes place in hives deprived of queens; here they are never destroyed; "on the contrary, while a savage massacre prevails in other places, they here find an asylum; they are tolerated and fed, and many are seen even in the middle of January. They are also preserved in hives, which without a queen, properly so called, have some individuals of that species that lay the eggs of males, and propagate only drones; therefore the massacre takes place in none but hives where the queens are completely fertile, and it never begins until the season of swarming is past."

About twenty days after the queen has begun to lay male eggs, the workers commence building royal cells, and the queen being now ready to lay female eggs, deposits them, at intervals of one or two days, in these cells. The form and position of the royal cells have been already described; the queen deposits her eggs in them soon after they are founded, after which the workers lengthen them to their full extent, which is about an inch. The royal egg is hatched in three days, and the young larva is watched with unceasing attention; it is fed with a jelly different from that which is supplied to the larvæ of the males and workers; it is more pungent, slightly acid, and so abundantly supplied, that after her change some of it is left in the cell. At the end of five days the royal cell is closed, and the larva begins to spin her cocoon, which she completes in



ROYAL LARVA MAGNIFIED.
(The lower figure is the real size.)

twenty-four hours. It is remarkable that this silken covering, unlike that of the males and workers, does not completely enclose the royal larva, but covers only the head and trunk, and the first segment of the abdomen. When her cocoon is completed she remains perfectly still for two days and sixteen hours, and then assumes the pupa state, in which she remains exactly four days and eight hours, making in all sixteen days, when she comes forth a perfect queen; she is not, however, permitted to leave her cell, but is kept a fast prisoner, for reasons which will presently appear; the workers, however, supply her with food, by piercing a hole in the cover of the cell, and inserting their proboscis; the royal prisoners continually utter a kind of plaintive song, the modulations of which are said to vary.

While all these proceedings are going on, the population of the hive is continually increasing, occasioning inconvenience from want of room, a great increase of heat, and a vitiated air. These circumstances probably lead to a migration, or *swarming*, as it is called, of a detachment of the hive. The best season for swarming in this country is from the middle of May to the middle of June, but swarms sometimes occur as early as the beginning of April, and as late as the middle of August; the first swarm is led by the reigning queen, and takes place when she has laid so many eggs as to be able to fly with ease. When the bees are preparing to swarm, a peculiar humming in the hive is heard the evening before, and is continued during the night; sometimes it is necessary, in order to hear this hum, to apply the ear close to the hive, when clear and sharp sounds may be distinguished, as if proceeding from a single bee. These sounds have been gravely construed into an harangue of the queen, to animate her subjects to the great undertaking which she now meditates—the founding of a new empire. A few evenings before swarming the bees cluster at the mouth of the hive, although this is often occasioned by extreme heat. Swarming generally takes place at noon, or during the hottest part of the afternoon, and little or no outdoor work is done during the morning. Sometimes, when all seems to be perfectly tranquil within the hive, a sonorous hum is suddenly excited, and the workers, as if seized with a panic terror, may be seen quitting their labours, and running off in different directions.

Huber has given an interesting account of the interior of a hive previous to swarming. "The queen, as soon as she began to exhibit signs of agitation, no longer laid her eggs with order as before, but irregularly, as if she did not know what she was about. She ran over the bees that stood in her way; they, in their turn, struck her with their antennæ, and mounted upon her back; none offered her honey, but she helped herself to it from the cells in her path. The usual homage of a court attending round her was no longer paid; those, however, that were excited by her motions, followed her, rousing such as were still tranquil upon the combs. She soon traversed the whole hive, when the agitation became general; the workers, no longer attentive to the young brood, ran about in all directions ; even those that returned from foraging, before the agitation was at its height, no sooner entered the hive than they shared in the tumult, and, neglecting to get rid of the masses of pollen on their hind legs, ran wildly about. At length there was a general rush to the outlets of the hive, and the swarm took place.

"It is to be observed that this agitation, excited by the queen, raises the customary heat of the hive to a very high temperature, which the action of the sun increases till it becomes intolerable, and which often causes the bees accumulated near the mouth of the hive to perspire so copiously, that those near the bottom, who support the weight of the rest, appear drenched with the moisture. This intolerable heat determines the most irresolute to leave the hive. Immediately before the swarming, a louder hum than usual is heard ; many bees take flight ; and if the queen be at their head, or soon follows them, in a moment the rest rise in crowds after her into the air, and the element is filled with bees, as thick as the falling snow. The queen at first does not alight upon the branch on which the swarm fixes, but as soon as a group is formed and clustered she joins it : after this it thickens more and more, all the bees that are in the air hastening to their companions and their queen, so as to form a living mass of animals supporting themselves upon each other by the claws of their feet.* After this they soon become tranquil, and none are seen in the air. Before they are housed, they often begin to construct a little comb on the branch on which they alight. Sometimes it happens that two queens go out with the same swarm ; and the result is, that the swarm at first divides into two bodies, one under each leader ; but as one of these groups is generally much less numerous than the other, the smallest one at last joins the larger, accompanied by the queen to whom they had attached themselves ; and when they are hived, this unfortunate candidate for empire falls sooner or later a victim to the jealousy of her rival. Till this great question is decided, the bees do not settle to their usual labours. If no queen goes out with a swarm, they return to the hive from whence they came."

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* See Frontispiece at page 2.

It is supposed by many apiarists that several days before swarming, the bees always send out scouts to select a new residence, and Dr. Warder considers that their clustering upon a bough, or other object near the parent hive, proceeds from their desire to be all congregated together, prior to their last flight. They have been known to select a deserted bee-hive, having first cleared it of all rubbish, &c., leaving only the old combs. Mr. Knight, in a letter to Sir Joseph Banks, published in the *Philosophical Transactions*, relates several instances tending to prove that bees send out providers. On one occasion he observed from twenty to thirty of them paying daily visits to some decayed trees about a mile distant from his garden : the bees appeared to be busily employed in examining the hollow parts, and particularly the dead knots around them, as if apprehensive of their admitting moisture. In about fourteen days these surveyors, if such they were, were followed by a large swarm from his apiary, which was watched the whole way till it alighted in one of these cavities, having been observed to journey nearly in a direct line to the tree. On several similar occasions the bees selected that cavity which Mr. Knight thought best adapted to their use. He also noticed that a stock being nearly ready to swarm, one of these hollow trees was daily occupied by a small number of bees; but the swarm from that stock being lodged in a hive, the tree was wholly deserted. This preference of a hive when offered, to a place previously chosen, Mr. Knight ascribes to a habit acquired by domestication, which produces a dependence upon man for providing a dwelling, and descends from the parents to their offspring.

The strongest objection to this previous selection of a place for founding the new colony is the fact, already mentioned, that the bees often commence comb-building upon the boughs on which they first alight when swarming. Mr. Knight's opinion, however, is supported by many well-attested facts, from which we select two. Dr. Evans relates that he suffered a hive, whose tenants had died in the winter, to remain upon the stand till spring; he then observed several bees paying it daily visits and busily employed within, but leaving it at the close of evening. These soon appeared to be the harbingers of a swarm; for early in June an immense body of these insects were seen rapidly approaching and then surrounding the hive: they took possession as quickly as its narrow entrance and crowded combs would permit.

A still more remarkable case is mentioned by Dr. Bevan as occurring to Mr. Estlin, of Bristol, no bees being kept within a mile of his house. He had lost the whole of his stocks during the autumn of 1836, one of the families thus lost having been procured from a friend's apiary, situated two miles from Bristol, with which it seems probable that some sort of acquaintance was kept up. The year 1836 was very unproductive of honey, and Mr. Estlin's bees, probably not having collected enough to support them through the winter, transferred what they did collect to the stock from which they issued, and then took refuge there themselves. This may be inferred from the clean state in which the deserted combs were found in the spring of 1837. This latter year affording better promise than the preceding one, when the swarming season arrived, those among the emigrants that survived the winter, recollecting no doubt the comfortable quarters with which they had been accommodated during the previous summer, would very naturally explore the spot, and finding their former habitation still provided with the fittings they had left behind them, as soon as they had brushed out the apartment, and given the furniture a fresh polish, left the temporary winter quarters with which they had been kindly accommodated by their friendly neighbours, and resumed the rightful possession of their former mansion, fairly hummed themselves in, of course escorting with them a reinforcement from the family of their hosts.

Some later observations made by Mr. Knight led him to the conclusion, that previous to each swarm issuing, it is not only decided what bees shall enter into it and what remain behind, but that the first place of congregating, as well as the intended place of residence, has been decided on and visited separately by all the bees that intend to emigrate, prior to the simultaneous issue of the swarm. It must, however, be stated that eminent apiarists are by no means agreed in Mr. Knight's view of the case, and it may therefore be dismissed in this place with the sensible remarks of Mr. Dunbar, who after discussing the facts for and against the question, says:—"The truth is, that writers on bees, like writers on other subjects, are fond of classing the acts and proceedings of their favourites under certain fixed and uniform rules, from which they are supposed never to deviate; whereas, daily observation may convince us that the bees, like ourselves, are often the slaves of circumstances, and that their instinct is frequently at fault. That a swarm often takes possession of a retreat previously selected, is, I think, an undeniable fact; but that it oftener blindly follows its queen, which flies heavily, and generally perches on the first bush in the line of her flight from the hive's mouth, and perhaps within the distance of three or four yards, is quite consistent with constant observation and experience."

The knowledge of the person of the queen, and of the fact that all the bees of the swarm implicitly follow her motions, have enabled some persons to perform feats with bees which appeared marvellous to the uninformed spectator. The celebrated Wildman had also a method of operating on the fears of the bees by confining them for a time, and then alarming them by drumming smartly on the outside of their hive. "When under the strong impression of fear," he says, "they are rendered subservient to our wills to such a degree as to remain long attached to any place they afterwards settle upon, and will become so mild and tractable as to bear any handling which does not hurt them, without the least show of resentment. Long experience has taught me, that as soon as I turn up a hive, and give some taps on the sides and bottom, the queen immediately appears. * * * * Being accustomed to see her, I readily perceive her at the first glance, and long practice has enabled me to seize her instantly, with a tenderness that does not in the least endanger her person. Being possessed of her, I can, without exciting any resentment, slip her into my other hand, and returning the hive to its place, hold her till the bees, missing her, are all on the wing and in the utmost confusion." When in this state he could make them alight wherever he pleased, for on whatever spot he placed the queen, the moment a few of them discovered her the information was rapidly communicated to the rest, who in a few minutes were all collected round her. In this way he would sometimes cause them to settle on his head, or to hang clustered from his chin, so as to resemble a beard. Again, he would transfer them to his hand, or any other part of his body, or if more agreeable to the spectators before whom he exhibited, would cause them to settle upon a table, window, &c. Before the time when he made his secret known, he deceived his spectators by using words of command, "but the only magic," says Dr. Bevan, "that he employed, was the summoning into activity for his purpose the strong attachment of the bees to their queen."

A knowledge of this fact has often been turned to good account in hiving swarms, and in extricating persons from apparently dangerous situations. The following remarkable instance is related by Mr. Thorley. Wanting to dislodge a swarm from the branch of a codlin-tree, he placed the hive in the hands of his maid-servant, who covered her head and shoulders with a cloth to guard her face ; on shaking the tree, most of the bees alighted upon the cloth, and quickly crept under it, covering the girl's breast and neck up to her very chin. Mr. Thorley impressed her with the importance of neither flinching from, nor buffeting the bees, and began immediately to search for the queen ; which on finding, he gently seized and removed, but without effecting a dislodgment of the swarm. Thus disappointed he suspected that there was a second queen, which actually proved to be the case. On securing and placing her in the hive, with a portion of the bees, the rest followed in multitudes, till in two or three minutes not one bee remained upon the girl, who was thus released from her state of apprehension and alarm without feeling the point of a single sting.

M. Lombard relates thefollowing case. "A young girl of my acquaintance was greatly afraid of bees, but was completely cured of her fear by the following incident. A swarm having come off, I observed the queen alight by herself at a little distance from the apiary. I immediately called my little friend, that I might show her the queen ; she wished to see her more nearly ; so, after having caused her to put on her gloves, I gave the queen into her hand. We were in an instant surrounded by the whole bees of the swarm. In this emergency I encouraged the girl to be steady, bidding her to be silent and fear nothing, and remaining myself close by her ; I then made her stretch out her right hand which held the queen, and covered her head and shoulders with a very thin handkerchief. The swarm soon fixed on her hand, and hung from it, as from the branch of a tree. The little girl was delighted above measure at the novel sight, and so entirely freed from all fear, that she bade me uncover her face. The spectators were charmed with the interesting spectacle. At length I brought a hive, and shaking the swarm from the child's hand, it was lodged in safety, and without inflicting a single wound."

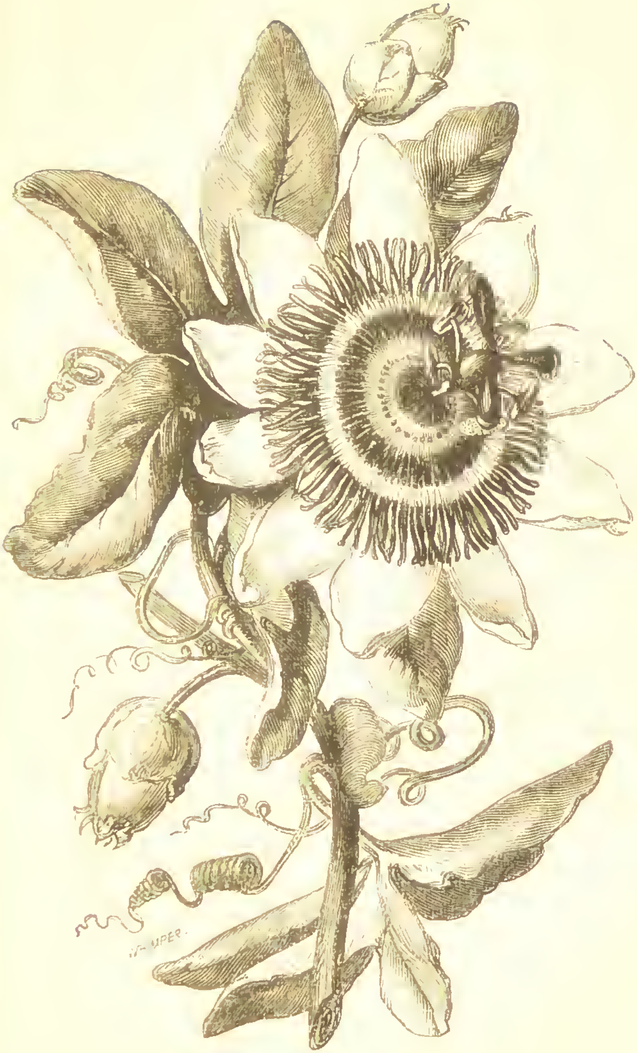
But it is time that we should return to the captive princesses in the hive from which the swarm has issued. No sooner has the old queen departed, than the eldest princess is elected to the vacant throne. If she is sufficiently matured she is liberated from prison, and those who were her guards now become her subjects. So long as the old queen remained, the females were not safe, for such is her fear of rivalry, and her jealousy towards her own sex, that she destroys without mercy all the young queens that come within her reach. The workers are therefore very anxious to prevent her even approaching the royal cells while there is any prospect of a swarm taking place. They form a guard around the royal cells, and actually beat off the queen if she endeavours to approach them. If, however, the swarming season is over, or circumstances prevent any further swarms from being sent off, the bees do not oppose the fury of the old queen, who immediately begins the work of destruction, tears open the royal cells, and transfixes with her sting, one after the other, the whole of the royal brood in their cells.

After the departure of the old queen with the first swarm, the young queens are liberated in succession, at intervals of a few days. No sooner is a young queen liberated than she displays the same anxiety as her mother to get rid of her sister rivals in the other royal cells. This, however, is prevented by the vigilance of the bees who guard them; but when the season is too far advanced for swarming, or when the hive is too much thinned by previous swarms, they no longer interfere, and the first queen that is set at liberty proceeds to massacre all her rivals. If two or more queens should happen to issue at the same moment, they seek each other out, and fight till one is killed, and the survivor is immediately received as the sovereign of the hive. The bees, far from seeking to prevent these battles, seem to excite the combatants against each other, surrounding and bringing them back to the charge when they are disposed to recede from each other; but when either of the queens seems disposed to attack the other, the bees which cluster round her open a path for her to attack her rival. One of the two is sure to be destroyed, and the conqueror immediately secures her victory and her sovereignty by destroying all her future rivals; while the other bees, in the true spirit of economy, devour any food that may be found at the bottom of the cells, and even suck the juices from the pupæ before they throw away the carcass. It has been previously stated, that the larvæ of the males and workers construct perfect cocoons; while those of the royal larvæ are imperfect, enclosing only the head, thorax, and first ring of the abdomen. Huber conceives that the intention of nature in this apparent imperfection is, that they may be exposed to the mortal sting of the queen, should circumstances require the sacrifice.

After the old queen has led away the first swarm, the bees in the parent hive quietly resume their labours; the young brood is soon matured, and the hive is again under the necessity of sending out a new swarm to relieve the superabundant population. The second swarm is sent off from five to ten days after the first, and it is led by the eldest of the young queens. Other swarms follow, but they consist of smaller numbers than the earlier ones. The number of swarms produced in a season depends on a variety of circumstances, such as the abundance of flowers, the warmth of the climate, the size of the hive, &c. Very few drones accompany the new colonies, so that most of those produced in the spring remain in the hive, and are destroyed by the workers in the manner already described.

The useless mouths being got rid of, the bees spend the remainder of the summer in laying in supplies of honey and of pollen for the winter. But these necessary articles are now much scarcer than in the spring, and greater exertion is required in collecting them. They attack fruit after birds or snails have removed the outer skin. They also consume *honey dew*, the sweet fluid which is dropped by the aphis. At this season also the Passion-flower affords a seasonable supply of liquid honey. The fondness of the bee for the honey of this flower is thus noticed by Mr. Wailes in the *Entomological Magazine.* He says, "Against the south front of our house, several plants of the *Passiflora Cærulea* are trained, which cover it to the height of some twenty feet, or thereabouts ; and, from July to November, the constant succession of its beautiful flowers attract great numbers of the hive-bee, especially during autumn, when flowers productive of much honey are scarce. Every one knows the passion-flower, and need hardly be told that one series of the rays of the nectary closely surrounds the stipes or shaft, whilst other two are beautifully spread over the horizontal leaves of the corolla ; but perhaps few are aware that the tube of the calyx contains several drops of pure and delicious honey. On the arrival of each bee, I can at once tell whether it has been a prior visitor or not, by its mode of procedure. Should it be a first visit, the little busy creature is for a time quite at a loss ; it, of course, scents the honey, but cannot discover the entrance to the store-house. Convinced that there is plenty of the object of its search in the flower, the bee hurries over the surface in all directions, now running its head fast between the corolla and the outer double series of the rays of the nectary, now entangling itself amongst the beautiful rays themselves, and anon mounting the stipes, and ransacking the parts of fructification. At length, after a bustling scene, which frequently last for two or three minutes, and which the bee's certainty that honey is concealed somewhere in the neighbourhood prevents its quitting in despair, sometimes apparently by mere chance, at others by running the scent home, its indefatigable labours are rewarded. Now, with its tongue inserted amongst the rays surrounding the shaft, and past the projecting rim which almost closes the entrance to the tube of the calyx, it drinks its fill, and flies off for the hive to deposit its treasure, and profit by experience on a future trip. Far different is the manner of the bee that has been at the work before; it wastes not a moment of the time which the approach of winter renders doubly valuable, but at once alights on the flower, runs to its centre, and plunging its tongue into the liquid sweet, hurries back loaded to the hive."

Much has been written on the pasturage of bees, and many lists have been made of bee flowers, and of such as should be planted round the apiary. Mignionette, borage, rosemary, bugloss and lavender: the crocus for early spring, and the ivy flowers for late autumn, are all useful in a garden, while the lime, the horse-chestnut, and the sallow, are the best trees to plant around. Dr. Bevan suggests that lemon-thyme should be used as an edging for garden-



THE PASSION-FLOWER.

(Passiflora Cœrulea.)

walks and flower-beds. But the bee is too fond of roaming for its pasture to be confined to a flower garden, however useful this may be as an auxiliary to the wild tracts of thyme, heath, and furze, the

WILD THYME.
(Thymus serpyllum.)

broad fields of beans and buck-wheat, the lime avenues, the hedgerow flowers, and the clover meadows, which are the favourite haunts of the bee. He is also fond of the white Dutch clover, sometimes called honey-suckle, and it is said that when there is plenty of this it is sure to be a good honey year.

Of course, much of the success in the management of bees must depend on the abundance of their pasture. A rich corn country is to them as a barren desert during a great portion of the year. Hence the ancient practice of shifting them from place to place, according to the circumstances of the season. In Scotland, the people of the Lowlands, as soon as the flowers of summer are on the wane, despatch their hives in cart loads to the blooming heather of the mountain pastures. A writer on this subject regrets that our moorlands in this respect are much more neglected than they ought to be. "The very air of the Highland hills is often redolent with the rich perfume, while here and there a solitary bee is seen or heard, labouring with wearied wing among the inexhaustible stores of nature, and scarcely able to regain its lonely shieling in the distant vale. When we consider the poverty of our mountaineers, and their frequent want of occupation, it is the more to be lamented that so easy a source of emolument should lie open to them in vain."

When the bee has filled its honey-bag, it next, by means of its feathered hairs, collects from flowers the fertilising dust of the anthers—the pollen for making bee-bread. Sometimes a bee is so discoloured with this powder as to look like a different insect, becoming white, yellow, or orange, according to the flowers it has selected.

It has been supposed that the bee visits only one species of plants during one excursion. Her instinct teaches her that the grains of pollen which form one load should be of the same kind, in order, perhaps, that they may knead together into one mass; and thus two important ends are served—the impregnation of those flowers that require such aid by the bees passing from one to another, and the avoiding the production of hybrid plants from the application of the pollen of one species to the stigma of another.

When the bee has completed her lading she flies home in a direct line to dispose of it. The honey is disgorged into the cells destined for its reception. She first breaks with her fore-legs a hole in the crust, which forms on the surface of the honey, and prevents it from running out; she then disgorges the contents of her bag in large drops, new models the crust, and closes up the hole. Some of the cells are filled for daily use; others, which are carefully sealed up with wax, form a reserve against bad weather or a bad season. The pollen is stored in cells, also set apart for the purpose. The bee fixes her middle and hind-legs firmly on the edges of the cell, and then sweeps with her fore-legs the pellets from their baskets into it. Another worker immediately inserts her head into this cell, and kneads the pollen with a portion of honey from her honey-bag. But the bees do not always disgorge their honey, for should they meet with some of their companions, which have been kept at home to work, they open their honey-bags, and give them refreshment as already noticed. According to Huber, honey for store is collected by the wax-makers only, the nurses gathering no more than is sufficient for themselves and their companions at work in the hive.

Bees go a considerable distance for honey, which they discover by scent. One or two miles round the hive is said to be the limit of their ordinary excursions. It is probable, on an average, each bee makes four or five excursions in a day, or, in small colonies, as many as six. If, however, the number employed within the hive in building and nursing be taken into account, the number of excursions to each bee is probably even greater than this. Suppose only the half a population of eighteen thousand to collect bee-bread in one day, the quantity would exceed a pound, so that in one season one such hive might collect a hundred pounds.

In times of scarcity, when no more honey is to be collected from the sources which nature has left open for all, the collecting instinct of the workers will prompt them to rob their neighbours. If not supplied with food they are, as it were, compelled to do this in the spring, when their winter stores are exhausted. When a hive determines to commence robbing, Keys says, "They send spies to discover the state of neighbouring stocks. A few of the spies, for several days, dodge about the doors, trying to get in to obtain some knowledge of their strength and riches; but are driven away by the powerful stocks, who plant guards at their doors, and as the weak stocks do not, they are therefore the first to be assaulted. The next day they return in force, and begin a violent siege; and a desperate conflict ensues, both within and without the hive, neither side giving quarter. The stoutest warriors make a desperate attempt, and rush forward and seize the queen, knowing that, by despatching her, instant victory is the consequence; for the assaulted bees always desist and join the victors the moment they are apprised of their queen's death, become as one fraternity, and assist to carry their own treasure to their new habitation. But in case the queen is protected, they fight on with rage and fury, and death and pillage soon destroy the stock."

These robber bees, or *corsair bees*, as they are called on the Continent, are sometimes said to unite in small parties of three or four, to rob on the highway. They waylay the straggling humble-bee as it returns to its hive loaded with honey; one seizes a leg, another a wing, another pummels its chest, or bites its head. Under this ill-usage the poor humble bee unfolds its tongue, and disgorges its honey, which the foot-pads eagerly lap till they are satisfied, and then let the prisoner go.

Such details as these ought to excite the humanity of all bee-keepers, to furnish food to their bees at proper seasons. They need not be fed throughout the winter, even during a mild season, because, if accustomed to be fed, they are tempted to quit the warm air of the centre of the hive, where they cluster in great numbers, and expose themselves to the colder air below, which is often fatal to them. They should have a supply of water, salt, and sugared or honeyed ale in the early part of the spring; that is, from about the beginning of the breeding season till May. It may seem an odd taste for animals that feed on sweets, to be fond of salt, but Dr. Bevan, an experienced bee-keeper, says, "I keep a constant supply of salt and water (about a tea-spoonful to a pint) near my apiary, in a shallow dish, covering the bottom with small pebbles, and find it thronged with bees from early noon till late in the evening. About this period the quantity they consume is considerable, but afterwards they seem indifferent to it."

The respect and affection of the workers for their queen, the acknowledged governor of the hive and leader of the colony, have been shown in some of the foregoing details. She is the object of constant and universal attention ; and, wherever she goes, is greeted by a homage which displays the entire devotion of her subjects. "She appears to be the very soul of all their actions, and the centre of their instincts. When they are deprived of her, they lose all their activity, and pursue no longer their daily labours. In vain the flowers tempt them with their nectar and ambrosial dust ; they collect neither ; they elaborate no wax, and build no cells ; they scarcely seem to exist ; and, indeed, would soon perish, were not the means of restoring their monarch put within their reach."

According to the experiments of Huber the bees are not immediately aware of the loss of their queen ; they continue their labours as usual ; but in a few hours they become agitated. A singular humming is heard ; the bees desert their young, and rush over the surface of the combs. They then seem to discover that their queen is no longer among them. If she be restored, all becomes tranquil in a moment. The substitution of another queen is not attended with the same effect, if she is introduced into the hive within the first twelve hours after the removal of the reigning one. The agitation continues, and the bees treat the stranger as an intruder ; they never use their stings upon a queen, but they surround, seize, and keep her captive during many hours, and form so thick a cluster about her, that she commonly dies from hunger or suffocation. If eighteen hours elapse before the new queen is introduced, the bees mob her as before, but for a shorter time. She seldom survives this treatment; but Huber has known queens to escape in good health after an imprisonment of seventeen hours, and reign in the hives in which they had been at first so badly received.

If, however, the new queen is not introduced until twenty-four hours after the removal of the old one, the stranger will be well received, and be allowed to commence her reign from the moment of her introduction into the hive. Huber describes the reception of a queen under these circumstances. He says, "Immediately on placing this female stranger on the comb, the workers near her touched her with their antennæ, and passing their trunks over every part of her body, gave her honey. Then these gave place to others that treated her exactly in the same manner. All vibrated their wings at once, and ranged themselves in a circle around their sovereign. Hence resulted a kind of agitation, which gradually communicated to the workers situated on the same surface of the comb, and induced them to come and reconnoitre in their turn what was going on. They soon arrived, and having broke through the circle formed by the first, approached the queen, touched her with their antennæ, and gave her honey. After this little ceremony they retired, and placing themselves behind the others, enlarged the circle, where they vibrated their wings, and buzzed without tumult or disorder, as if experiencing some very agreeable sensation. The queen had not yet left the spot where I had put her, but in a quarter of an hour she began to move; when the bees, far from offering any opposition, opened the circle at that part to which she turned, followed her, and surrounded her with a guard."

A queen being so necessary to the welfare, or rather to the very existence, of a colony of bees, the question may be asked, what are they to do if accidentally deprived of her? We have seen that the loss of a queen spreads terror and alarm through the hive; this, however, does not last long; the sagacious insects hasten to supply their loss by a contrivance which has excited perhaps greater astonishment than any other fact in the history of insects. The bees actually have power to form a queen out of the grub of a worker, by enlarging its cell and feeding it in a particular manner with what is called *royal jelly*, which is more stimulating than bee-bread. In order to produce this effect the grub must not be more than three days old, but it may be less. The bees, having chosen a grub, remove the inhabitants and their food from two of the cells which join that in which it resides; they next take down the partitions which separate these three cells; and leaving the bottoms untouched, raise round the selected room a cylindrical tube, which follows the horizontal direction of the other cells; but since, at the close of the third day of its life, its habitation must assume a different form and direction, they gnaw away the cells below it, and sacrifice without pity the grubs contained in them, using the wax of which they were formed to construct a new pyramidal tube, which they join at right angles to the horizontal one, the diameter of the former diminishing insensibly from its base to its mouth. During the two days which the grub inhabits this cell, which, like the common royal cell, has now become vertical, a bee may always be observed with its head plunged into it, and when one quits it another takes its place. These bees keep lengthening the cell as the worm grows older, and duly supply it with food, which they place before its mouth, and round its body. The animal, which can only move in a spiral direction, keeps incessantly turning to take the jelly deposited before it; and thus slowly working downwards, arrives insensibly near the orifice of the cell, just at the time that it is ready to assume the pupa. The workers then cover in its cradle, and the larva undergoes its change into a royal nymph.

Schirach, the naturalist who discovered this extraordinary fact, found that if a number of bees be confined with only a single larva, which, in the natural course, would have become a working bee, they immediately set about giving it the royal training above described, and thus raise it to the dignity of a queen.

Huber has many interesting experiments on this subject, which can only be glanced at in this short notice. He deprived a hive of its queen, and put into it some pieces of comb containing only worker eggs. The same day several cells were enlarged and converted into royal cells, and the larvæ were supplied with abundance of jelly. Huber then removed these worms from the royal cells, and put in their place common worms from workers' cells. The bees did not seem to be aware of the change, but watched with the greatest care over the new worms. They continued to enlarge the cells, and closed them at the usual time. From these common worms two queens were hatched almost at the same moment, of the largest size, and well formed in every respect. This experiment seems to be perfectly satisfactory, especially when taken in conjunction with many other similar results obtained by eminent entomologists.

Great difference of opinion has existed among naturalists, as to the means by which the bee finds its way back to the hive, and distinguishes its own residence from that of others. Some believe that it is simply by the sense of vision; others refer it to hearing, and others to the sense of smell. But when a bee is returning to its hive, its flight is usually in a direct line, and hence it would appear to be guided by the sense of vision, which is the most perfectly developed of all the senses of insects. In order to settle this point of dispute, Mr. Newport, on the 11th of March, removed one of his straw hives from the closed bee-house, in which it had stood through the winter, to a stool in the open air, within sight of, but at a distance of about ten or fifteen yards from the bee-house. On the following day scarcely a bee went abroad, either from the bee-house or the removed hive, or from another straw hive which stood very near to it ; the weather being exceedingly wet and boisterous. The 13th was a remarkably fine day, and many bees went abroad, both from the bee-house, and from one of the straw hives, and return loaded with pollen, but not a single bee was observed to return to the straw hive that had been removed, and very rarely any to depart from it. But a few bees were frequently seen descending towards and alighting at the entrance hole in the bee-house, from whence that hive had been removed. This entrance hole had been closed since the removal of the hive, and the bees collected around it made many attempts to enter, and were quickly in a state of great excitement. On opening the hole, and allowing them to enter, they ran around the place on which the hive had stood, in great agitation, vibrating their half-closed wings most rapidly, and touching each other repeatedly with their antennæ, as if in a state of frenzy. Two or three bees then issued from the entrance hole, and after taking a circling flight twice or thrice in the air, at some distance from the bee-house, as if to reconnoitre the spot, alighted again at the hole, and ran about within in the same state of consternation as before. After continuing in this state for some time, they flew to the entrance hole of the hive which remained in the bee-house, but were very badly received. The bees of that hive resisted and maltreated them, and several fights ensued, in which the intruders were killed. It was thus evident that these bees belonged to the hive that had been removed, which, perhaps, they had left but a short time before, without reconnoitring the new locality of their residence, which a bee seldom or ever appears to do when its hive has remained undisturbed on the same spot for any great length of time, and consequently, having never distinguished their home but by the exterior of the bee-house, they now returned directly to the spot where they had been accustomed to enter. This experiment seems to show that the bee is not conducted by the sense of smell, either of the honey, or of the inhabitants of the hive, or it could hardly have been attached to a spot from whence these were removed. Neither can we suppose that it was directed by the sense of hearing, or it could hardly have failed to recognise the sounds in its own hive, which stood at so short a distance ; while the circumstance of its flying directly to the spot where it had formerly entered, and that of its leaving the entrance-hole on finding the hive removed, and then flying around in the air as if to reconnoitre the bee-house, and alighting a second time at the same hole, seem to prove that the great faculty exercised by it, in discerning its home, is that of sight. This experiment seems also to prove, why so few bees left the removed hive, those which had gone out not having returned, as Huber believes, to apprise the population that remained of the quantity of honey abroad, or of the favourableness of the atmosphere for collecting it.

The structure of the organ of vision in the bee is entirely in accordance with the usual mode of proceeding of this insect, and illustrates the fact of the bees leaving the bee-house, and flying around in the air, as if to reconnoitre the spot ; and also another fact, that for the first few days after a swarm has been hived, the bees seldom fly far, and each bee, on first leaving the new hive, usually makes several circuits around it in the air, at greater and greater distances, with its head constantly directed towards the hive, as if to reconnoitre the spot, before taking a distant flight.

Among the many curious and ingenious arrangements of the hive is that of *ventilation.* The thousands of bees which occupy so small a cavity as that of a hive, would in a very short time so vitiate the air as to render it quite unfit for the purposes of respiration, unless means were taken to renew it ; and so effectually is this done, that the air of a well stocked hive is kept as pure as the external air. The method of accomplishing this was discovered by Huber and his son. They found that the bees, by uniting the two wings of each side by means of small marginal hooks with which they are provided, so as to make them present the largest possible surface to the air, were capable of striking it with considerable force. The wings thus arranged are put into a rapid vibratory motion by workers appointed to the office of ventilators. They station themselves in files at the entrance of the hive, with their heads turned inwards ; another and a larger party, in files also, stand a considerable way in the interior, with their heads towards the entrance : thus both these parties cooperate in producing a current of air in the same direction, and they are so arranged as not to block up the entrance to the hive. This hard work is kept up during the day, and in hot weather by night also, by distinct gangs of ventilators, each gang doing duty for about twenty-five minutes. When thus engaged, the bees fix themselves as firmly as possible, by means of their feet and claws, to the place they stand upon. The first pair of legs is stretched out before, the second extended to the right and left, whilst the third, placed very near each other, are perpendicular to the abdomen, so as to give that part considerable elevation. The motion of the wings is so rapid as to render them almost invisible.

The condition of the hive during the winter has led to some difference of opinion among naturalists. Réaumur expressly states, that " during the greater part of the time in which the country furnishes nothing to bees, they have no longer need to eat. The cold which arrests the vegetation of plants, which deprives our fields and meadows of their flowers, throws the bees into a state in which nourishment ceases to be necessary to them : it keeps them in a sort of torpidity in which no transpiration from them takes place, or at least during which the quantity of what transpires cannot be restored by food without their lives being endangered." Swammerdam, Huber and others maintain, on the contrary, that bees do not become torpid in winter, but that even in severe frosty weather a populous hive is able to maintain a temperature of from 86° to 88° Fahrenheit. Mr. Newport had long doubted this latter statement, which is so much at variance with every thing that is known respecting the habits of insects in this country, especially those of the same class, the Humble Bees, that were it really the case it would form a singular exception to the general economy of British insects. He therefore instituted a series of experiments with a view to determine the question. The bulb of a thermometer was passed into the hive through a small opening in the upper part, and so arranged that while the bulb remained fixed within, the scale projected on the outside, so that the temperature of the interior could always be ascertained at a glance. A second thermometer on the outside showed the temperature of the external air. By observing these thermometers several times a day during the whole of the winter, Mr. Newport was able to prove that the hive bee does hybernate; it certainly does not become torpid, but if entirely undisturbed, it passes into that condition in which its temperature of body and quantity of respiration are very greatly diminished. In fact, the bee falls into a state of deep sleep in the combs, from which it is roused by a very low temperature, and then the bee exerts its wonderful faculty of raising the temperature of the hive by increasing the number of its respirations. If the bees are disturbed from this sleep, as they readily are, their agitation soon raises the temperature of the hive to a great height. Mr. Newport justly supposes that this led M. Huber and other observers into error, for on introducing a thermometer into the hive they could not help disturbing the bees. If, however, the temperature be noted day by day while the bees are asleep, it will be found that there are periods when the temperature of the hive is so greatly reduced that it is scarcely above that of the open air, and when the temperature of the atmosphere increases rapidly, that of the hive remains below it for a short period.

It appears from one observation of Mr. Newport, that bees are able to bear a degree of cold below the freezing point. On the morning of the 2d January 1836, just before sunrise, there was a clear intense frost, and the thermometer in the open air stood at 17½°: the bees were perfectly quiet and the thermometer in the hive showed a temperature of 30°, that is, 2° below the freezing point. The bees were roused by a gentle tapping on the hive, and in sixteen minutes the mercury had risen to 70°, that is, 52° above that of the external air. This, however, was not the temperature of the hive, but that of a cluster of excited bees about the bulb of the thermometer, for on introducing a second thermometer at the distance of a few inches from the first, the temperature was only 45°.

During winter the bees are occasionally tempted out by a bright sunshine, when the ground is perhaps covered with snow; they soon get chilled in the open air and perish by hundreds. Indeed, throughout the year the workers are exposed to so many accidents from rain, wind, and sudden changes in the atmosphere, that few workers, it is supposed, live more than six or eight months. The queen, seldom going abroad, is less exposed to accidents, and her life is prolonged to several years. Mr. Duncan had a queen which he had every reason to believe was not less than four years old.

Bees have many enemies, among which may be mentioned the lark and other birds, which catch them as they fly, and the swallow, which will visit the hive and devour them by dozens. The frog and the toad kill great numbers of them, and such as fall into the water are probably devoured by fish. Simple immersion in the water does not kill them, for if taken out after many hours and placed in the sunshine they recover. Rats and mice, especially the field-mouse, are great enemies of bees, particularly in winter. Mr. Thorley once lost a stock by mice, which made a nest and produced young amongst the combs; and another writer says he has known a mouse take up his winter quarters in a hive without destroying the bees. This shows how necessary it is to secure the base and contract the opening to the hive. It is cruel to stop up the opening altogether, not only because the bees cannot live without fresh air, but because, being extremely neat in their persons and habitation, they never void their excrements in the hive, but retain them until they can go out of doors. If they are entirely shut up their bodies become so swollen that numbers of them perish. Another enemy of the bee is the titmouse, which it is said will make a noise at the door of the hive, and when a bee comes out to see what is the matter, will seize and devour it. In this way he will secure a dozen in succession. Earwigs and ants will also creep into the hive and steal the honey. But the most formidable insect enemies of the bee are perhaps the wasp and the hornet, which often seize and devour them, even ripping open their body to get at the honey bag. A band of wasps sometimes takes possession of the hive, and having destroyed or driven away all the bees, regale themselves on the honey. The death's-head hawk-moth also makes its way into the hives and steals the honey. This insect has the faculty of emitting a shrill mournful cry, which Huber supposes may produce an effect upon the bees similar to that caused by the voice of their queen, which as soon as uttered strikes them motionless, and thus it may be enabled to rob with impunity in the midst of myriads of armed enemies. Another dangerous enemy is the wax-moth, which insinuates itself into the hive through any crevice that may be left open, or even through the common entrance to the hive unless the sentinels are very vigilant. The wax-moth lays its eggs in the sides of the hive, or among the rubbish on the floor, or even in the combs at the back of the hive. In a short time each egg produces a worm or larva, which builds galleries or covered ways throughout the interior of the hive, devouring neither honey nor wax, but the exuviæ of bee nymphs, and even, it is supposed, the nymphs themselves. Under the attacks of this insect the population of the hive becomes greatly reduced, until at length the poor bees abandon their home ; in due time the larvæ of the wax-moth become perfect insects, and issue forth to carry on their destructive labours in other hives.

The list of insect enemies of the bee is not yet complete ; there are several lice and parasites which torment her, some of which hide in flowers, and when the bee comes to collect honey fasten on her body.

Bees, like other animals, are subject to disease. In some seasons there is a general mortality, which carries them off by thousands. This often happens in a cold moist spring, when little or no pollen can be collected; and without pollen no brood can be raised. The bees are also subject to dysentery, which is said to be sometimes produced by their feeding on honey-dew, on the juices of certain fruits, on plants of a poisonous nature, or on honey alone, without a proper mixture of pollen. Some writers say they are also subject to vertigo, tumefaction of the antennæ, &c.; but Mr. Duncan thinks that dysentery is the only serious disorder to which they are liable. Dr. Bevan prescribes for their ailments, strict cleanliness, and timely supplies of sugared ale, particularly during February and March.

The poor bees are also liable to be killed by their master for the sake of the honey and wax, unless he has learned the humane, the sensible, and the economical method (so well enforced, in a book which no keeper of bees ought to be without,*) of sharing the profits with the bees, and saving their lives.

"Thou wert out betimes, thou busy, busy Bee!
As abroad I took my way,
Before the cow from her resting-place
Had risen up, and left her trace
On the meadow, with dew so grey,
Saw I thee, thou busy, busy Bee!

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* "My Bee-Book," by the Rev. W. C. Cotton. London, 1842.

"Thou wert working late, thou busy, busy Bee!
After the fall of the cistus flower;
When the primrose of evening was ready to burst,
I heard thee last, I saw thee first;
In the silence of the evening hour,
Heard I thee, thou busy, busy Bee!

"Thou art a miser, thou busy, busy Bee!
Late and early at employ;
Still on thy golden stores intent,
Thy summer in heaping and hoarding is spent
What thy winter will never enjoy;
Wise lesson this for me, thou busy, busy Bee!

"Little dost thou think, thou busy, busy Bee!
What is the end of thy toil;
When the latest flowers of the ivy are gone,
And all thy work for the year is done,
Thy master comes for the spoil:
Woe then for thee, thou busy, busy Bee!"
SOUTHEY.

In perusing this history of the hive-bee the reader will find omitted such details as relate merely to the management of hives. These do not enter into the plan of this little book; but the writer trusts that enough has been said to justify the eloquent remark of the Rev. Mr. Kirby: "What a wonderful idea does this [history] give of the industry and activity of these useful little creatures! And what a lesson do they read to the members of societies that have both reason and religion to guide their exertions for the common good! Adorable is that Great Being who has gifted them with instincts which render them as instructive to us, if we will condescend to listen to them, as they are profitable."

NEST OF THE HUMBLE BEE.

THE BEE,

AS AN EXAMPLE OF ECONOMY.

PART II.—HUMBLE BEES.*

HUMBLE BEES form a very interesting portion of our social insects, although, compared with hive bees, they have been called rude and untutored villagers. As an example of economy they are inferior in interest to the hive bee, but their history is extremely curious, and well calculated to furnish us with a lesson. "Their comparatively large size and gay colours, render them conspicuous objects in our fields and gardens; the untiring diligence with which they seek their food among the blossoms, 'so busy and so pleased,' can hardly be observed without pleasure; while their incessant hum, which often assails our ears in heather uplands, where nearly all other indications of life have ceased, forms one of the most common of those rural sounds, the entire effect of which is usually so agreeable."

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* This term is derived from the German *Hummel*, or *Hummel-Biene*, a name probably given to the insect from its sound. It has been suggested by Kirby and Spence, that our English name would be more significant were it altered to *Humming* or *Booming-Bee*. In the following notice the writer is indebted for several details to the inquiries into the economy of the humble bee, undertaken by the younger Huber to soothe the declining years of his aged parent. In his memoir on this subject, published in the sixth volume of the Transactions of the Linnean Society, he apologizes for giving to the world the researches of a young naturalist of nineteen.

Humble bees were formerly classed with the hive bee, under the common name of *Apis;* but they are now separated, and the generic term *Bombus* applied to them. Upwards of forty different species are said to belong to Britain, but as in individuals of the same species the downy covering of their bodies changes with age like the plumage of birds, it has been thought probable that members of the same family have been described as of different species. The two species to which the following notice is chiefly confined are, the common humble bee *(Bombus Terrestris)* and the moss or carder bee *(Bombus Muscorum).* These are most common in this country ; and their habits scarcely differ.

A colony of humble bees consists of four kinds of individuals, namely, *large and small females, males, and workers;* the number of members in one colony is very small compared with that of the hive bee, seldom exceeding two hundred ; in some species it is as low as fifty or sixty, and in others the number has not exceeded twenty.

FEMALE.

WORKER.

MALE.

Early in spring, as soon as the catkins of the sallows and willows are in flower, a large solitary female may be seen about them collecting honey and pollen. She is the only survivor of the former year's colony, and is now about to found a new one. Her first care on awaking from her winter's sleep is to excavate a hollow in the earth for her nest, which is often above a foot under the surface, and is entered by a passage or gallery. She sets about this laborious task, in which she is quite unassisted, by loosening the soil with her fore legs, and transferring it to the middle ones; these convey it to the hind legs, which push it away as far as possible.* As soon as the excavation is complete, she lines it with soft leaves and similar substances, and then proceeds to construct waxen cells for her brood. This part of the work is accomplished with great activity, for she can build a cell, fill it with honey and pollen, (the food of the young,) deposit one or two eggs in it, and cover them in, in little more than half an hour.

HUMBLE BEE. *(Large female.)*

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* Huber suggests the probability of the humble bee sometimes sparing herself the trouble of excavating, by occupying a cavity formed by the mole and other animals.

A number of these cells are constructed, enclosing workers' eggs and pollen. In May, the eggs are hatched into little worms, which are carefully tended by their mother; they increase rapidly in size, and in due time spin a silken cocoon, and afterwards become nymphs or pupæ. In this state they remain motionless until the moment when they cast off their swaddling clothes and come out of their cradle; then their wings expand, their body is covered with hair, which soon displays a variety of colours, and they immediately begin to help their mother in her toils with a skill equal to her own.

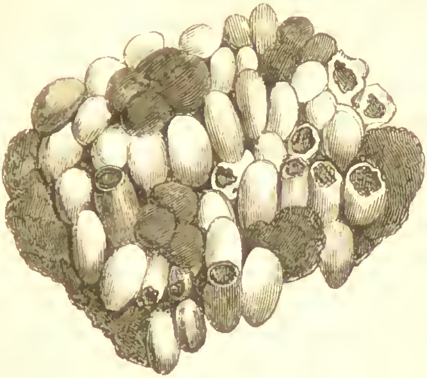
The next brood of the foundress of the colony consists of large and small females and males: these appear in August or September. The workers are the most numerous portion of the population, and have abundant employment throughout the summer. One of the first cares of the workers of the common humble bee is to line the roof of their nest with wax, to keep it warm and to prevent water from filtering through. The wax of these insects is not so delicate, so white, so firm, or so fusible as that of the hive bee, nor is it applied to such exquisite architecture; it is brown and soft, but well adapted to the rude works of their nest. It is formed in wax-pockets similar to those of the hive bee, and is moulded in plates to the shape of the insect's body. Unlike the queen of the hive, the foundress of this colony secretes wax, and does so even more abundantly than one of her workers.

The workers of the moss or carder bee cover their dwelling with a thick vault or coping of moss; and they have a singular method of transporting this material. Having discovered a parcel of moss conveniently situated, they place themselves upon it with their heads away from the spot to which they mean to convey it. They then take a small portion, and with their lower jaws and fore legs disentangle it by a process resembling carding or combing, which has given the popular name to this insect. When the moss is sufficiently carded it is passed under the body by the first pair of legs; the middle legs receive and deliver the pieces to the hind legs, which push them as far as possible beyond the insect. When by this contrivance the bee has formed a small mass of well carded moss, then either the same or another who takes her turn in the process pushes it nearer to the nest. In this way small heaps of moss are conveyed to its base, and in a similar manner are elevated to its summit, or where they are most wanted. A file of four or five insects is often occupied at the same time in this employment.

CARDER BEES TRANSPORTING MOSS.

If the carder bees cannot procure moss, they will make use of other materials for covering their nest. Huber had a colony of carder bees in his study, covered with a bell glass, from the bottom of which proceeded a glass tube leading out of the window, by which the bees could go out and come in. As the bell glass did not completely cover the nest, he secured it with some coarse cloth, a portion of which was within the glass. The bees soon began to attack this cloth: they tore the threads apart, carded them with their teeth, and reduced them to the form of mere filaments: they next collected those filaments into flocks, which they pushed away with their hind legs. A number of the bees were continually occupied in carding, and others in removing the carded material to a distance. At the end of three or four weeks they had entirely covered in their nest with a layer of this substance, in some places as much as an inch and a half in thickness, and they even introduced a quantity of it within the nest, filling up the space between its edge and that of the comb. On another occasion Huber had covered a glass containing some carder bees with a book: the industrious little insects cut the book to pieces, and covered in their nest with the shreds.

The interior of a humble bee's nest has none of the beauty and regularity of the hive. Instead of a number of vertical combs of wax, there is a confused and clumsy assemblage of egg-shaped bodies, of dirty-coloured wax, placed one above the other, forming a series of horizontal combs, the uppermost resting upon the more elevated parts of the lower, and connected together by small pillars of wax. These egg-shaped bodies are of three different sizes,



CELLS OF THE HUMBLE BEE.

those in the middle being the largest, closely joined to each other, and each group connected with those next it by slight joinings of wax. These oval bodies are the silken cocoons spun by the young larvæ; some are closed at the top and include inmates; others, chiefly in the lower combs, are open, the young bees having escaped from them. On the surface of the upper comb are several masses of wax, of a roundish and irregular form, about 1¼ inch in diameter and half an inch deep; these are brood cells, containing each six or seven larvæ, lying close together upon a quantity of pollen and honey, placed there for the purpose of nourishing them as soon as they are hatched. When this food is consumed, the workers make an opening in the top of the cells, and by means of their proboscis introduce new supplies, taking care to seal up the cells again. As the grubs increase in size, the cells which contain them are frequently split by the motions of the young inmates; the workers fill up these cracks with wax as fast as they occur, and in this way the cells gradually increase in size in proportion to the growth of the larvæ. The cells are opened and food is supplied from time to time, until the larvæ change into pupæ, when no more food is given and the cells are finally closed. The workers also frequently brood over the pupæ shrouded in their cocoons, in order to impart the necessary degree of heat. This part of their labours will be noticed at greater length presently. Lastly, in different parts of the nest, wherever there is a vacant space, we notice a considerable number of small goblet-shaped vessels, containing honey and pollen. These honey pots are formed by the workers out of the empty cocoons; they trim them up, cut off fragments of silk, and give the opening a regular circular form ; they strengthen it by a ring of wax, and then line each vessel with the same material. Some nests contain as many as fifty or sixty of these honey pots, more than half of which are often filled in a single day. These stores are for daily use, and therefore are never sealed over like the honey cells of the hive bee, because all the colony except one large female dies at the approach of winter, and she remains torpid during that season.

It has been already stated, that the first brood of the mother are all workers, which assist in the business of the nest, and relieve their parent of much of her toil. When she is about to deposit in the cells the eggs from which the second brood is to spring, the workers by a strange instinct endeavour to seize the eggs and devour them. It has been suggested that the object of the workers in doing so is to keep down the population of the nest; but however this may be, it is certain that the mother has to exert all her boldness and caution to protect her eggs. Sometimes she pursues several workers to the extremity of the comb, while others, watching the opportunity, steal upon the cell, carry off the eggs, suck out the milky juice, and then cast away the thin transparent membrane which forms the shell. At length she succeeds in depositing a number of eggs in the cell, which she supplies with pollen moistened with honey, and then closes it up with wax; she then takes her station on the cell and keeps guard over it for six or eight hours, frequently wheeling her body round as if to defend her progeny. After this period, strange to say, the workers make no further attempts to devour the eggs or destroy the cells; the mother commits them to their charge, and they zealously perform the office of nurses. Huber has even placed before them old eggs at the very moment when they were making desperate attempts to get at and devour the fresh ones; they took the old eggs, and carefully shut them up in a cell, without once attempting to eat them.

From the eggs thus rescued by the mother are produced a few large females, and several small females and drones. The large females when first hatched, not being in a condition to lay eggs, are regarded with indifference by the small females; they busy themselves in the ordinary occupations of the colony, collecting honey and pollen and making wax, but they do not construct cells. Their building instinct does not display itself till the following spring, when they are about to found a new colony. The small females very much resemble the workers; these are waited upon by the males who form their court. The males are smaller than the large females, and larger than the small ones and workers. They are not an idle race, like the drones of the hive, for although they do not collect provisions, they secrete wax and work with the rest in keeping the house in repair. Like the drones, they have no sting; but unlike them, they are not massacred when their services are no longer required. They live on till autumn, and seldom survive the first cold weather of that season. The small females also perish in autumn.

When the small females, which produce only male eggs, are about to lay, the jealousy of the old queen is excited to the utmost, and the whole nest becomes a scene of confusion. Huber, watching at midnight the proceedings of a nest which he kept under a glass, observed many of the bees engaged in making a cell. The queen mother came and drove them away; she in her turn was driven away by her small rivals, who pursued her, beating their wings with the utmost fury. Two small females then succeeded in depositing eggs in the cell; the queen returned, fierce and angry, drove them away, put her head into the cell, seized the eggs and devoured them. The same scene was repeated with the same results.

After this, one of the small females returned and covered the empty cell with wax. When the mother queen was removed, several of the small females quarrelled for the possession of the empty cell, all endeavouring to lay their eggs in it at the same time.

It was stated in Part I. page 34, that the bees, in brooding over the cells which contain nymphs, have the power of increasing the heat of their own bodies many degrees above that of the air about them, and that they do this by increasing the number of their respirations. Among hive bees, according to Huber, the nurses perform this office; but among humble bees Mr. Newport has discovered that the young females are so employed, crowding upon and clinging to the cells very closely, during which time they respire very rapidly and are evidently much excited. This work is begun about ten or twelve hours before the nymph makes its appearance as a perfect insect, the workers scarcely leaving the cell for a single minute, or if one bee quits her post another immediately takes her place. Before this period the brooding over the cells is done only at intervals, but is more constantly attended to as the time approaches for the little prisoner to escape. By carefully introducing a thermometer among a group of these nurses in a nest of humble bees which he had domesticated, Mr. Newport obtained a temperature of 89°, while that of the open air was only 72½°. A few hours after, the brood cells showed a temperature of 92½°, while that of some of the adjoining cells was only 80°.

It is a curious fact that these bees do not brood on the cells which contain only larvæ, the temperature of the nest being sufficiently high for them in that condition. On one occasion Mr. Newport found the temperature of a larva cell 77½°, while that of the cell of a nymph with nurse bees upon it was 92°, and afterwards 94°, the temperature of the atmosphere being 72½°.

"The greatest amount of heat is generated by the nurse bees just before the young bees are liberated from the combs, at which period they require the greatest amount of invigorating heat. It is at this period also that the young bee is most susceptible of diminished temperature; it is then exceedingly sleek, soft, and covered with moisture, perspires profusely, and is highly sensitive of the slightest current of air. It crowds eagerly among the combs and among the other bees, and everywhere where there is the greatest warmth. In the course of a few hours it becomes stronger, and is less sensitive, and better able to bear a diminished temperature. It then moves about with less circumspection, and its wings, which are at first soft and weak, and bent upon its trunk, become plain and straight. When a young bee first leaves its cell, it is entirely of a whitish or pale grey colour, but within half an hour the black markings on the thorax become very distinct, although they retain a tinge of grey colour for a much longer period; the yellow bands on the body and thorax are at first quite white, and it is not until an hour or two has elapsed that the principal yellow band on the thorax begins at length to gain colour, while it is several hours before the yellow bands acquire their full shade or degree of colour. During all this time the bee continues in an enfeebled state, and takes no part in the business of the nest, but seeks for itself the warmest place among the combs; and it is not until some time after it has acquired its proper degree of colour, that it becomes active like the other bees, and is able to maintain its own proper temperature."

Huber relates an interesting anecdote of some nurse bees. While conducting an experiment respecting the formation of wax,* he placed a piece of brood comb, with a dozen bees, under a glass vessel, taking away from them every particle of wax, and supplying them with pollen only. The comb, from the irregularity of its shape, did not rest steadily on the table, and when the bees mounted on it, to impart the necessary warmth to the brood, its rocking motion seemed to annoy them exceedingly. They had no wax with which they could remedy the evil, but their instinctive affection for their young suggested a contrivance as strange as it was ingenious. A few of them mounted the comb, and letting their bodies down, suspended themselves from it head downwards, by the hooks of their hinder feet; and with those of the second pair of legs, which are very long, laid hold on the table, and thus steadied the mass by the strength of their bodies. In this posture they remained till relieved

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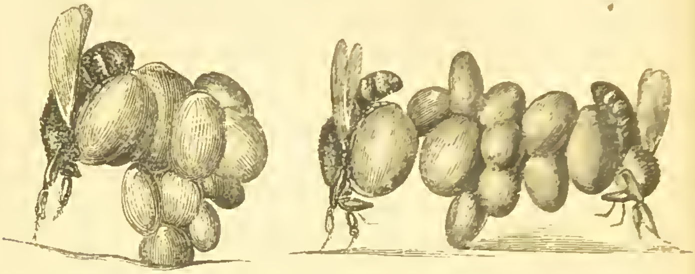
[*] The rapid formation of wax in the case of humble bees is very remarkable. Huber confined a number of them, and fed them during many days with pollen only; they produced no wax, constructed no cells, and laid no eggs; but on giving them honey, wax was produced in a few minutes, and the work of the colony proceeded.

by others, the mother herself lending her aid, and they continued the painful task for two or three days. In the mean time, Huber had furnished them with some honey, from which they produced wax,



HUMBLE BEES SUPPORTING A BROOD COMB.

and with it immediately began to build up pillars from the table to the comb ; they were thus relieved from their toil, but it was only for a short period, for the wax getting dry, the pillars gave way, and the poor insects were again compelled to prop up the tottering mass with their bodies, when Huber, pitying their condition, glued the comb firmly to the table.

It is the opinion of Huber, that the development of the large and small females depends upon the nature of the food with which they are supplied during their larva state; as in the case of the hive bee, the food of the different individuals of the humble bee differs, for the grubs that are to become workers are fed with a paste of honey and pollen, while those destined to be males and females are supplied with pure honey. It is not, however, possible to explain how this difference is brought about, for the large and small females, which are reared in the same cells and on the same food, are as distinct in appearance as in habits.

The difference between the hive bee and the humble bee, with respect to temper, is very remarkable; the former is irritable, and impatient of observation: the latter is indifferent to the presence of a spectator, and while collecting honey will even permit itself to be touched or stroked, without getting angry. Huber relates a curious anecdote, illustrative of the easy temper of the humble bee. Some hive bees, in a time of scarcity, paid a visit to a nest of humble bees contained in an open box near the apiary, for the purpose of begging or stealing their honey. "The hive bees, after pillaging, had almost taken entire possession of the nest; some humble bees which remained, in spite of this disaster, went out to collect provisions, and bringing home the surplus, after they had supplied their own immediate wants, the hive bees followed them, and did not quit them till they had obtained the fruit of their labours; they licked them, presented to them their proboscis, and at last persuaded them to part with the contents of their honey-bags; after this the humble bees flew away to collect a fresh supply. The hive bees did them no harm, and never once showed their stings, so that it seems to have been persuasion rather than force that produced this singular instance of self-denial. This remarkable manœuvre was practised for more than three weeks, when some wasps being attracted by the same cause, the humble bees entirely forsook the nest."

In collecting honey, if the humble bees cannot get at that contained in a flower by its natural opening, they will often make an opening at the base of the corolla, or even in the calyx, that they may insert their proboscis into the very midst of the precious store. They are especially fond of the nectar of the passion-flower, and its effects upon them are amusingly told in the following extract from the Gardener's Chronicle:—

"We regret extremely to announce that some honest humble bees of our acquaintance have taken to drinking, and to such excess that they are daily found reeling and tumbling about the door of their houses of call—the blossoms of the Passion-flower, which flow over with intoxicating beverage; and there, not content with drinking like decent bees, they plunge their great hairy heads into the beautiful goblet that nature has formed in such plants, thrusting each other aside, or climbing over each other's shoulders, till the flowers bend beneath their weight; after a time they become so stupid that it is in vain to pull them by the skirts, and advise them to go home, instead of wasting their time in tippling: they are, however, good-natured in their cups, and show no resentment at being disturbed; on the contrary, they cling to their wine goblet, and crawl back to it as fast as they are pulled away, unless, indeed, they fairly lose their legs, and tumble down, in which case they lie sprawling on the ground, quite unable to get up again." Mr. Kirby remarks that these jovial, reckless proceedings of humble bees, contrast strongly with the temperate habits of hive bees, which, having drunk temperately from the same source, hurry back to their hive; and "the way in which the humble bees suffer themselves to be cajoled out of their honey by hive bees, shows such a good-natured weakness of disposition, as may easily be supposed to be combined with a propensity to carousing when the opportunity presents." To this easy temper also is due the comparative facility with which they may be studied. Mr. Newport removed a nest containing forty or fifty individuals, from the earth to his residence, and placed it in a small breeding cage. At first the bees were very angry, and were therefore kept in close confinement, and fed with moistened sugar; but within a day or two they became quite accustomed to their new residence. On the third day they were placed on a table in the sitting room, near the window, which remained open; the door of the cage was also left open, that the bees might go abroad and return at pleasure, which they did with as much regularity after the first day or two, as if the nest had been in its proper locality in the earth. Another nest was caged in a similar manner; the bees were at first greatly affected and agitated by the slightest noise, such as the removal of a chair, or footsteps about the room, or the passing of a carriage along the road, which was at least thirty feet distant from the window of the apartment; but they were not in the slightest degree affected by persons talking loudly in the room, while a gentle tap with the finger on the table put them immediately into a state of the greatest agitation. In a day or two they also became accustomed to their situation, and were not disturbed by slight noises. Mr. Newport has noticed a difference in temperature of nearly 12° between the excited and the tranquil state of this nest.

The nests of humble bees are subject to the attacks of many enemies, the most formidable of which are ants, the field-mouse, and the weasel. The pole-cat will sometimes destroy more than a dozen nests in a single night. One of M. Réaumur's nests had been plundered, but the bees had escaped and were found in the morning flying about their ruined abode. In order to encourage them to re-establish their nest, M. Réaumur gave them a comb taken from a nest which had been deserted on account of the incursions of ants. "It appears," he says, "that I had made them an agreeable present; but not being satisfied with the place where I had put it, they passed beneath it, and by dint of lifting and pushing, they got it into the middle of their nest. I helped them to make a new cover of moss, which they arranged in their own way. They then set to work to make a honey-pot, which they attached to the edge of the comb, and filled it with honey in the course of the same day."

THE BEE,

AS AN EXAMPLE OF ECONOMY.

PART III.—SOLITARY BEES.

THE various species of hive bees and humble bees live in societies more or less numerous, all the members of each society doing something for the common good. Hive bees, with the exception of the drones, survive the winter, and even the drones are permitted to live throughout that season, should the prosperity of the hive require their presence.* Humble bees die at the approach of winter, one large female only of each colony surviving, to found a new colony in the following spring.

In addition to bees which live in societies, there are several species which lead a solitary life, each one working only for itself, regardless of other individuals of its species which may be near. The female has no workers to build her nest or to collect honey and pollen for her young; she is not even assisted by the male; but alone and unaided she provides for her progeny with a skill and perseverance which are indeed admirable. All her actions seem to be prompted by the tenderest affection for the young that she is destined never to behold; she provides for events which are to take place after the lapse of days, weeks, and even months; she seems to be well acquainted with all the wants of her young, and provides for them with admirable foresight, for truly God "doth instruct her to discretion, and doth teach her."

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* See Part I. p. 37.

The history of many of the solitary bees has been beautifully told by Réaumur, from whose great work on insects the following details and wood-cuts are chiefly selected. This eminent observer, comparing the works of insects with human arts, first gave to bees, wasps and caterpillars those names which are so well calculated to arrest attention, by indicating the character of their labours. Réaumur's idea has been followed out to a certain extent by English naturalists, and those bees which burrow in wood are called *Carpenter-bees;* those which form their nests in stone, clay, or sand, are termed *Mason-bees,* while those which burrow in the earth are called *Mining-bees.* The terms *Upholsterer-bees* and *Tapestry-bees* are perhaps a little more fanciful; such bees form their nest, or some portion of it, with the leaves of trees, or with the petals of flowers. The history of all these bees is highly curious and instructive; and perhaps in no part of the insect world is the *economy of time* better illustrated than in their proceedings.

THE CARPENTER BEE.

In one of the bright days of early spring a large dark-coloured fly may occasionally be seen on the sunny side of a wall in our gardens, sometimes rising and hovering over it, then making several turns in the air, and again hovering over another part of the same wall. She then disappears, but is sure to return after some hours, making a loud buzzing noise. She may also be seen during several successive days; and is easily distinguished when the wings are spread out, for they make her appear larger then she really is. She exceeds in size the queen bee of the hive, and if covered with hair would be nearly as large as the mother of the humble bees. Her body is smooth and shining, and of a bluish black colour; it is of a somewhat flattened shape, and is furnished with four wings of a darkish violet hue: the abdomen and the corslet are fringed with black hairs.

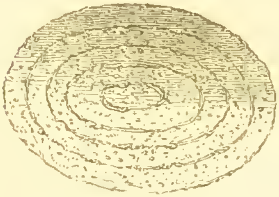
CARPENTER BEE *(Female).*

This is the female carpenter bee, looking out for a proper place to commence her labours. She is examining the posts, palings, and props of trees, and at length finds one adapted to her purpose. She never attacks living trees, nor a piece of timber that is still green, nor will she select a piece situated in a shady place. She knows that a piece of dry timber exposed to the sun will give her less trouble, and will also supply warmth to her brood. Having therefore chosen a piece of wood, say a cylindrical upright post, she bores a hole in it, at first inclining slightly downwards, but when it is a few lines deep, she bores it in a direction parallel with the sides of the post, and at length forms a cylindrical hole or funnel, not less than twelve or fifteen inches long, and half an inch in diameter. Sometimes, when the post is sufficiently stout, three or four of these pipes, nearly parallel with each other, are bored in the same piece. This laborious work occupies the insect weeks, and even months, and the only instrument with which it is performed is her strong mandibles, formed each of a solid shelly substance, curved, and terminating in a fine but strong point. The chips of wood, resembling saw dust, which result from boring, are from time to time turned out at the entrance hole, and they form a heap on the ground below. These chips are afterwards applied to an ingenious use, as will be noticed presently.

MANDIBLE OF THE CARPENTER BEE (*magnified*).

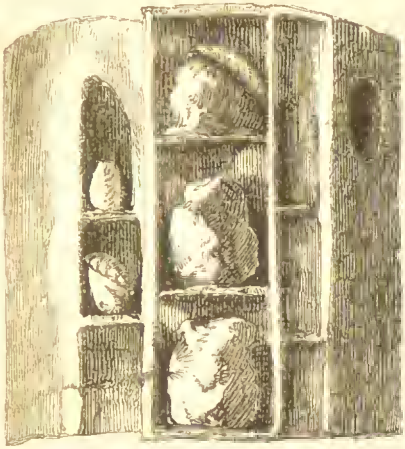
Severe and tedious as this labour is, it is only a small part of what the insect has to perform. The eggs which she is about to lay must neither be heaped up in a pile, nor scattered at random about the tunnel; the grub which proceeds from each egg requires an apartment entirely to itself, so that this long tube is only the shell of a building which is to be divided into rooms or cells, separate from each other; and, what is still more surprising, each of these cells must be stored with a quantity of provisions exactly sufficient to support the young grub from its birth, until the time when it changes into the pupa state and requires no food. Well may Réaumur exclaim, "What mother among us knows exactly the number of loaves of bread, the quantity of meat, and the food and drink of all kinds, which her child will consume from its birth till it can take care of itself!" And yet this bee, with a tender and enlightened foresight of which there are so many examples in the insect world, has this knowledge, and provides accordingly.

The mother having completed the long tube or shell of her house, next begins to lay in a store of bee-bread, which is of a reddish colour, and is composed of pollen well moistened with honey. These materials are industriously collected from the neighbouring fields and gardens, and the insect stores them in the very bottom of the tube until they form a loaf of bee-bread about three-quarters of an inch high. Within or upon this bee-bread the insect deposits a single egg, and then proceeds to cover it over with a sort of scaffolding of wood, which serves as the floor of the second cell. In the construction of these floors she makes use of the fibres or saw-dust from the heap on the outside. She glues the particles of saw-dust together, and also to the sides of the tunnel, forming a sort of ring projecting inwards. When this is sufficiently hardened, its interior edge affords support for a second ring of the same materials, and thus the ceiling is gradually formed of these concentric circles, till there remains only a small opening in its centre, which is also closed with a circular mass of agglutinated particles of saw-dust. When this partition, which serves as the ceiling of the first cell and the flooring of the second, is finished, it is about the thickness of a crown-piece, and exhibits the appearance of as many concentric circles as the animal has made pauses in her labour. One cell being finished, she proceeds to form another, in which she deposits a store of bee-bread and an egg, and then finishes and completes it in the same manner; and so on until she has divided the whole tunnel into ten or twelve apartments.



DIVISION OF CELLS.

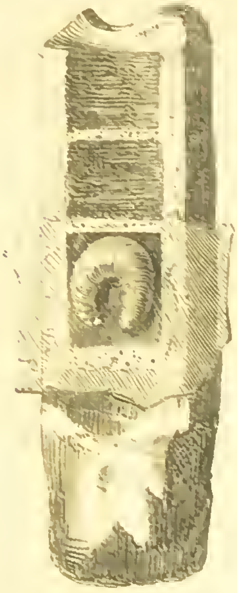
When one of these cells is thus closed in, the bee has accomplished her task with respect to its tenant. She has provided a secure abode, and has stored it abundantly with food. When the grub has consumed all this, it will be ready to spin its cocoon, become a nymph, and afterwards a perfect insect. The food which the careful mother has stored up is not liable to decay, or to any kind of change, for being contained in a closely-sealed cell, it does not lose its moisture by evaporation, nor imbibe any noxious



CELLS OF THE CARPENTER BEE.

principle from the atmosphere. The quantity of food in each cell is so abundant, that the grub has but very little space for moving about, and as it increases in size the food diminishes in the same proportion. There is an excellent reason for this narrow accommodation, as will be noticed presently.

In order to watch the changes of these insects, M. Réaumur took a piece of wood containing some of their nests, and cut away a portion sufficient to lay open two cells, each of which contained a grub; but as this exposure to the air would have proved injurious, if not fatal to them, he covered the opening with a flat piece of glass, through which he could easily observe the proceedings within. Our ingenious observer began to watch them on the 12th of June, when the cells were almost full of bee-bread, and the two grubs had not escaped from their shell. Each occupied in its narrow cradle the small space left between the wall of the cell and the loaf of bee-bread: they often shifted their position, being sometimes at the top of the loaf, at other times at the side, and also at the bottom. The bread diminished every day. On the 27th of June it was almost entirely consumed in each cell, and the grub, curled up in the form of a ring, nearly filled its cradle. On the 2d of July the provisions were entirely consumed, nothing remaining but some small black oblong grains of excrement. During the next five or six days they were entirely without food, and appeared very restless: increasing the curvature of their bodies, bringing the head down to the floor of the cell, and then raising it again. By these motions they prepared for the grand operation by which they changed their state of worms for that of nymphs or pupæ. From the 6th to the 8th of July they got rid of their skins, and became nymphs.



CELLS OF CARPENTER BEE.

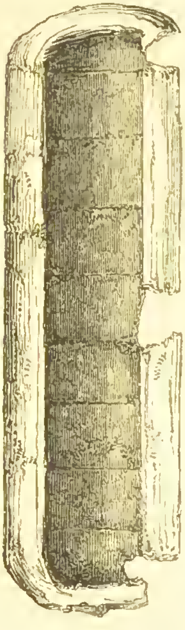
The grubs of the carpenter bee are very white: the head is small, and furnished with two very distinct teeth. Both the grubs and the nymphs very much resemble those of the hive and humble bees. The nymphs are at first extremely white.

but they gradually acquire a few tints of brown, after which they become brown, and then of a blackish hue. On the 30th of July, the body and corselet of those which had quitted the grub state on the 7th or 8th of the same month, were of a fine shining black ; the legs and wings were still of a coffee-brown colour, but they became black two or three days later. The nymphs were then in a condition to quit their shroud, and escape into the air as perfect insects.

We have seen that the parent has to perform a distinct series of operations for each cell ; she has to collect a supply of bee-bread, to deposit an egg, and to cover in the cell with a ceiling of wood : these operations occupy many weeks of incessant labour, so that on opening a piece of wood containing these cells, we find the young brood in various stages of advancement : some have nearly completed their transformations, others are grubs of various sizes ; some of the cells are nearly full of bread, others are almost or quite empty.

In a vertical, or nearly vertical range of cells, the lower cells are, of course, older than the upper ones, and in them the changes of the grub into the perfect insect are first completed. When the final change is effected, that which had hitherto been a cradle, now becomes a prison, from which the captive must and will escape. But how ? Is she to eat her way through the upper cells, injuring or destroying their tenants ? No, the beautiful foresight which has hitherto been displayed has also provided for this emergency.

It was stated that before the grub changes into the nymph state, its head is bent down to the lowest part of the cell; the nymph also remains with her head in this position, so that when the last change is effected, the perfect bee occupies its narrow cell with its head downwards; and as she is now endowed with organs of locomotion, and is anxious to use them, she naturally presses forward, in doing which she is led away from the upper cells towards an opening, which Réaumur thinks is provided by the mother, in the lower part of the tunnel. The young captive might have been taught to pierce a hole through the wall of her cell, but that would have been too hard a task for her mandibles, which are not yet sufficiently hardened: and besides, if she did escape in this manner, a piece of wood containing a number of cells would have an equal number of openings at the side, like the finger-holes of a flute, but these holes are not found. It appears, therefore, most probable, that as the bees are perfected, they bore their way into the cells below them, from which their sisters have already flown, and so escape by the lowest opening. In some cases Réaumur discovered an opening midway between the top and bottom holes. This is probably intended to abridge the labour of those bees which occupy the upper cells, and also to



SECTION OF CELLS.

lessen the fatigue of the mother in turning out the chips formed during the boring of the tunnel. On looking at the section of this little insect-house of nine rooms, perhaps some of our young readers may call the lowest room the kitchen, with an opening into the area; the middle opening may lead from the drawing-room out upon the balcony; while the top opening may conduct from the attic to the roof.

Such is the history of the female carpenter bee. The male is of about the same size as the female, and similar in appearance; he has no sting, but the female has a very large one.

Réaumur remarks, that there is, perhaps, no animal which does not serve to nourish other animals; none which may not bear to others, smaller than itself, the same relation which our earth bears to us. Thus our carpenter bees constitute the world to a species of louse, very minute, but furnished with two hairs on each side of the abdomen, three or four times longer than its body. These remarkable appendages, which would seem calculated only to embarrass their owner, doubtless have a use; but our cautious authority says, that were he to attempt to say what that use is, he should, probably, only deceive himself and his readers.

THE MASON BEE.

THE architecture of the mason bee, like that of the carpenter bee, is performed entirely by a solitary, unassisted female. It requires the same unceasing toil, and its object is also the same, namely, to provide a home for the young brood, where, surrounded by abundance of food, each grub, as soon as it quits the egg, may feed in security, and undergo those changes which nature requires of it, before it assumes the imago, or perfect insect form.

The exterior of a mason bee's nest gives but little idea of the skill with which it is constructed, and would not lead one to suppose it to be the habitation of insects. It has often exactly the appearance of a handful of mud taken out of the road and flung against the wall, where it has dried into a hard cake. At other times, these nests appear like dabs of mortar, carelessly left by bricklayers or masons on the wall.

A careful observer, however, would soon be convinced that these cakes of mud are not placed on the walls by accident. They are not found on walls exposed to the north, but are common upon those with a southern aspect. If they are found upon walls facing the east or west, it is in places where they can receive the direct rays of the sun for a few hours in the morning or evening.

The outer surface of the nest is a shell or covering to a number of cells made of the same material, which is a kind of mortar, applied in a moist state, and capable of hardening into a stony substance. To break it requires an iron tool ; and the blade of a knife is often too weak to do so. On this account the mason bees are careful not to attach their nests to white-washed walls, nor to the mortar or cement which binds the stones together, for were they to do so, the foundation of their building would be weaker than the building itself. They prefer surfaces of hewn stone, the angles formed by ornaments, plinths, cornices, the projecting parts of windows, &c. A nest lodged in an angle is better supported than it would be on the plain surface of the wall ; but it generally happens that a hewn surface offers a number of little inequalities, which serve as well as an angle to support the nest.

It has been said that the exterior of these nests offers nothing to excite attention, and during the greater part of the year the bees are not even seen near them. As soon as their building is complete, and properly furnished, the little architects abandon them, and return to them no more. During ten or eleven consecutive months these nests are inhabited at first by grubs, then by nymphs, which at length become perfect bees, some of which are able to use their wings by the end of April, and begin to work in their turn in building nests in which to deposit eggs.

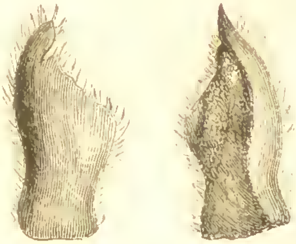
Each nest is an assemblage of many cells, and each cell contains a single white worm, without legs, and similar in appearance to the grubs of hive and humble bees. Some are transformed into bees of a black colour, but more velvety than the carpenter bees, and with a yellowish tinge below the posterior part. Others are changed into bees of a fawn colour, approaching that of hive bees, and a great part of the body is covered with hair. Both descriptions of bees are nearly of the same size, which is commonly about that of the hive drone. The black are females, and have a sting; the fawn-coloured are males, and have none.

MASON BEE.
(Female.)

In conformity with the law which seems to prevail in the insect world, the males lead a life of comparative idleness, while the female has all the toil of providing for the young family; and it is indeed severe. Each one, unassisted, has to build one, or several nests, according to the number of eggs she has to deposit; and her method of building has been admirably described by M. du Hamel, from whose minute details, as also from M. Réaumur's observations, the following particulars are selected.

As soon as a mason bee has made choice of a proper site on some stone wall, she proceeds in search of materials for her nest, which is formed of a sort of mortar, the basis of which is sand, as is also the case with the mortar used by our bricklayers and masons. She knows as well as they do, that every sort of sand will not make good mortar; it must be of a certain degree of fineness, neither too large nor too small; and it is her own fault if she does not choose the best, for she selects it grain by grain. She may often be seen bustling about a gravel path, or a sand-heap, from the latter of which our stonemasons take their sand indifferently; but she makes a proper selection. She also knows that to make mortar something more than sand is necessary. We make use of slaked lime and water; but nature has furnished the mason bee with a peculiar secretion, which answers the purpose of lime. With this secretion she moistens a grain of sand, which makes it adhere to a second grain; a fresh supply of moisture makes this take up a third, and thus she proceeds until she has collected a little pellet of sand, about the size of a small shot; this she kneads up with a certain quantity of earth, or garden mould, and then takes it between her mandibles, and flies off with it to the spot chosen for her nest.

The mandibles of the mason bee are of great strength, and larger than those of the hive bee; they are pointed at the extremity; convex above, and concave below. The reader will remember that the hind legs of the worker hive bee are furnished each with a little basket, or cavity, in which she conveys the pellet of pollen to the hive. The mandibles of the mason bee are used for the same purpose; they are so shaped, that the inner side of



MANDIBLE OF THE MASON BEE.

(Upper and under Surface.)

one exactly fits the inner side of the other, and when closed they form a cavity sufficient to hold the pellet of mortar, which the edges of the mandibles, fringed with hairs, prevent from falling out.

When the bee has found a heap of sand to her mind, she takes her supply from that alone. During five or six days in succession, and at almost all hours of the day, M. Réaumur has watched a single mason bee transporting sand. He has even got so near as to examine her through a magnifying glass. She chose fine grains of river sand, and formed them into a small pellet between her mandibles; she then flew to another sand-heap, fifteen or twenty feet off, from which also she took some grains, and then repaired to her nest, which was about a hundred paces off. All the walk was covered with the same kind of sand, and no difference could be distinguished between that of the two places from which the bee selected, each containing fine and coarse grains. "All that I can infer from this proceeding," says our cautious observer, "is, that the bee was a better judge of sand than I, and that her eyes enabled her to distinguish differences which escaped mine, such as certain roughnesses of surface, which might be of use to her."

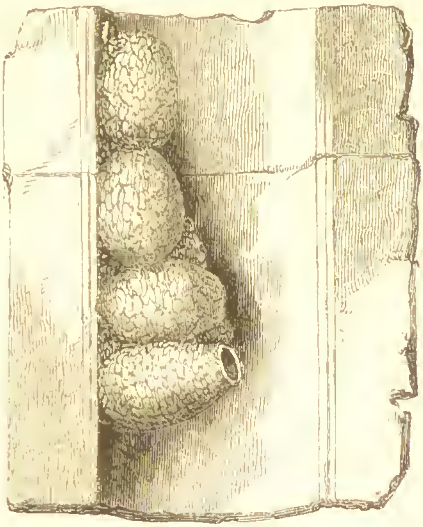
The task which our little architect has to perform, is to construct a nest composed of several cells, of similar form and capacity. Before being closed up, they are cup-shaped, as shown in the accompanying figure. She builds these cells one after the other, not beginning a second until

UNFINISHED CELL.

the first is quite or nearly finished. Her method of building is as follows. With a number of pellets of mortar, she forms a little disk, slightly concave, and upon this builds a sort of miniature round tower, by heaping up her pellets in rings. Suppose the little builder to be just arrived with a load of mortar; she balances herself at the very edge which she wishes to elevate, remains quiet for a moment, and then proceeds to knead the mortar she has brought, now raising and then lowering her head, turning the pellet over and over again, with the assistance of her fore legs and mandibles. She next examines well the spot where it is to be applied, and having decided upon this, moistens her work to make the new materials adhere better, and fits and adjusts them in proper form, dividing the pellet into two portions, if it is too large to be applied whole. In these operations, her mandibles form a very efficient trowel, with which she thins off and smoothes the surfaces, supporting with her legs the yet soft and plastic mortar. Her legs, especially the front pair, are of great use; striding across her work, some of her legs are in the cavity, others on the outside, pressing it, patting it, and helping to make it perfect. She may sometimes be observed putting her head into the cell, as if to survey her work; and she takes care to leave the interior smooth and polished, while the exterior is left rough. Each cell is about an inch high, and nearly six lines in diameter; a tolerably large edifice for a poor little fly, and yet she generally manages to build one cell in a day. Well may Réaumur remark, that considering the number of journeys she has to take to procure materials, she really does deserve the character of a diligent and laborious work-woman.

But she has even more important duties to perform than building. When a cell has been raised to about two-thirds of its height, she repairs to the flower-beds and to the fields, to collect honey and pollen, filling her stomach with the one, and forming the other into a pellet, which she conveys between her mandibles to her cell. Her body is also covered with pollen, which she brushes off into the cell, and then disgorges a quantity of honey, and kneads the two into bee-bread. She uses more honey for this purpose than the carpenter bee, or else her honey is more fluid, for it sometimes escapes through her cell to the outside, an accident which she knows how to remedy with a few pellets of mortar.

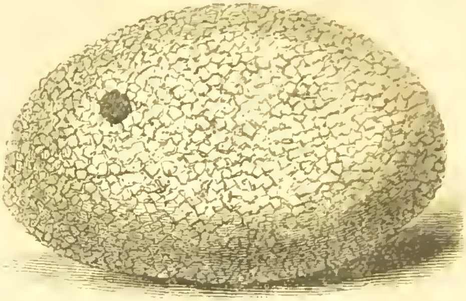
Having filled the unfinished cell with as much bread as it will hold, she increases its height, giving it the appearance of the lowest cell in the following cut. She then lays a single egg in it, and completes the supply of food; for, like the carpenter bee, she seems perfectly aware how much will be necessary for each of her young brood, from the time of quitting the egg until it becomes a pupa. Finally, she plasters up the mouth of the cell, as shown in the last but one in the cut ; and having thus completed her task with respect to this cell she takes no further notice of it, but proceeds to lay the foundation of a second, which she fills and finishes like the first. She often makes seven or eight cells in one nest; sometimes only three or four. She places these one above the other without much regularity, giving them different inclinations, and



CELLS OF THE MASON BEE.

afterwards filling up, with a coarser kind of mortar, the empty spaces left between them, her object apparently being by this means to add to their strength and solidity; but not content with this, she covers over the whole with an outer shell or case of masonry, thereby concealing all the cells, and giving a globular or oblong appearance to her nest. This shell is also made of coarser materials than those employed in the cells, requiring less care and trouble in collecting and conveying.

M. du Hamel has observed some curious facts, which, he thinks, prove that all this labour and fatigue are any thing but a pleasurable employment of the faculties of our little architect. We cannot suppose but that the insect finds pleasure in obeying the strong impulses of maternal instinct; and although she may sometimes, through an act of injustice on the part of one of her own species and sex, be driven away from her nest and see it appropriated, this does not prove a want of pleasure in her labours; on the contrary, the resolution with which she defends her property shows the great interest she takes in it; and if she is sometimes overpowered, it simply proves that might may overcome right, and that the spirit of injustice, which but too commonly vitiates the proceedings of men, may also be traced in the affairs of insects.



EXTERIOR OF MASON BEE'S NEST.

M. du Hamel's observations are to the following effect. While our little builder is abroad collecting materials, another bee will sometimes enter the unfinished cell, take possession of it without ceremony, examine it on all sides with attention, work at it, and re-adjust some of the still soft pellets, just as if it were her own property. When the rightful owner returns laden with fresh materials, the usurper prepares to defend her ill-gotten property, and the other is equally zealous to recover it. A combat ensues, which is often carried on for half an hour at a time. The air is their battle-field, and they fly with heads opposed. One endeavours to attain a higher elevation than the other, and she who is able to do so usually has the advantage. She aims a blow at the lower one, which, when it takes effect, is often so violent as to fell her to the earth. The lower one endeavours to avoid this blow, or to lessen its force by plunging downwards, or by flying backwards,—a method of flight unknown to birds. In fact, during these combats they fly in all directions, forwards, backwards, upwards, and downwards, in order each to escape the attacks of the other, or to assume a position favourable for making her own. Sometimes one ascends vertically for a time, and then suddenly descends upon her antagonist, endeavouring to throw upon her the whole weight of her body. At other times, in flying to attack each other their heads meet with such force that both are stunned, and they fall to the earth, whereupon a combat of a different kind is waged; each tries to pierce the other with its sting; but it seldom happens that the combat on either side is mortal. One, exhausted by fatigue, loses courage and flies away, in which case she is generally not pursued, the victor quietly taking possession of the disputed cell; but if the vanquished bee returns to it, the combat is renewed.

But the mason bee may sometimes obtain possession of a nest without the trouble of building one, and without committing an act of gross injustice. In one of the numerous journeys of the little builder, some accident may befall her, and she may not be able to return, in which case her unfinished nest may be fairly claimed by the first comer. In like manner, old nests from which the young brood has escaped are public property; these are often taken possession of, cleaned out, and properly repaired, filled with bread, an egg deposited in each, then sealed up, and lastly covered over with a common envelope. These old cells are a more frequent source of contention than the new ones, and the fighting on their account is perhaps less blamable than in the case of a new cell, for, being public property, they belong to the whole race of mason bees. and if there is any right in the matter it ought to rest with the first occupant.

These nests are of so solid a nature that they are calculated to last almost as long as the wall to which they are attached, and can scarcely be destroyed except by man, who, indeed, seldom notices them, or takes them for what they really are; and, besides, they are usually situated in places accessible only by means of tall ladders. Such being the case, it may naturally be asked, Why do not the mason bees, like the rooks and some other animals, always seek out and make use of the old nests? In answer to this M. Réaumur remarks, that a nest which has been used only once may be fit to use again; but not more than twice, for the repairs required may so add to the mass that it may not be penetrated by the warmth of the sun; or the old nest may be occupied by enemies, and the mason bee would hardly place her eggs among those which would destroy her offspring, the object of all her labours and cares.

Mason bees have been observed building as early as the 15th of April; but not later than the end of June. They probably perish, as most insects do, when they have placed their eggs in security. After the parents have died off, the race of mason bees exists only in embryo, in the form of grubs, shut up in their solid cells, from which they do not emerge till winter is over. Before the end of autumn the grubs have consumed all their food; they then spin a silken cocoon, which, on the outside, is so smooth and compact as to appear like a delicate white membrane. Before October they are transformed into nymphs, and early in November the perfect flies may be found in many of the cells. The grubs that are hatched somewhat late in the summer remain in that state during the winter. None of the perfect insects attempt to escape until they feel the influence of the warm sun of spring shining on the exterior of the nest. During this interval of repose their mandibles have become sufficiently hard to pierce the thick strong walls of their house. It has been supposed that the parent, before she abandons her nest, makes an opening in each cell, and in the outer case, for the escape of her progeny, covering up the holes with some softer material; such, however, is not the case, as is proved by the fact that some weak flies, not being able to pierce through the mortar, perish in their cells. M. du Hamel covered a nest over with a glass vessel, firmly cementing it to the stone to which the nest was attached. The vessel had an open neck, about two inches in diameter, which he stopped with a plug of gauze, through which the air passed freely. About the 20th of April three fawn-coloured flies appeared in the glass vessel, after having quitted the nest by three holes which they had severally pierced. (One of these holes is shown in the nest, represented at page 112). They made many attempts to escape from the vessel, and not being able to do so, they at length died of hunger. They had succeeded in piercing a mortar as hard as stone, and yet made no attempt to get through a piece of simple gauze. Insects soon become embarrassed if any addition is made to the task which nature has assigned to them.

Enclosed within these solid walls one would suppose the young grubs to be quite secure from the attacks of enemies, and it is probable that no enemy from without seeks to injure them; but they often have enemies within, of which their careful mother is ignorant. While she is out foraging, the stealthy ichneumon deposits as many as from ten to thirty eggs among the bee-bread, which are sealed up in the cell, together with the egg of the mason bee. Soon after the grub appears the ichneumon worms are hatched, and they fasten on the body of the grub, deriving their sustenance from it, but carefully avoiding any vital part until the grub has consumed the whole of its bee-bread, and then it is entirely devoured.

The grubs of the mason bee have also another enemy, which is conveyed in an egg to their nest. This egg is hatched into a caterpillar, which is armed with strong teeth, by means of which he devours the inhabitant of one cell, and then pierces his way into another, where he finds a second victim, and so on to a third, and even to a fourth, his appetite being adapted to the nymph as well as the grub of the mason bee. By the time he has despatched the inhabitant of the fourth cell he has grown as large as one of his victims; his body is then of a fine red colour, a shade darker than that of the rose; a few hairs are scattered over the surface; the head is black and scaly, and furnished with a good set of teeth; he has six scaly legs, and one leg at the extremity of the body. This caterpillar is transformed into a beautiful beetle, resembling the common cantharides. The head and corselet are blue; its wing-cases red, with dark violet stripes placed obliquely. This beetle watches its opportunity while the mason bee is collecting materials or provisions, to deposit its egg in one of her cells.

It is supposed that to guard in some measure against the attacks of such insidious foes, is the reason why the mason bee, as soon as she has constructed a cell sufficiently large to contain her person, passes the night in it with her head downwards. At other times she is content with a night's lodging in a hole in some wall.

The ant is also a great enemy of this diligent bee. While labouring to fill up a cell with bee-bread, her hoard may be discovered by a solitary ant, who hastens to inform her companions, and soon hundreds arrive to pillage the whole. In such a case the poor bee is often compelled to abandon her nest, knowing that the ants would devour her honey as fast as she collected it. But she will not abandon her nest for a slight cause. On one occasion M. du Hamel seized a bee with a pair of forceps, when on the point of entering her nest; he took her to his study, which was in front of his house, while the nest was attached to the garden-wall behind; on setting her loose in the study she escaped by the window, and arrived at her nest as soon as M. du Hamel, who went to it immediately. On another occasion she did not find it for a quarter of an hour.

These nests vary in colour, according to the colour of the sand or gravel, or other materials of the neighbourhood where they are collected. In some places they are constructed of clay or of earth mixed with chalk, and in others of earthy substances and wood. However massive and solid these nests may appear, they are sufficiently porous for air to penetrate them, for without air no animal can live. M. Réaumur proved this fact by taking a tube open at both ends, and closing one end with a piece of one of the cells, securing it to the tube with wax: he then filled the tube with mercury, and inverted it so as to form a column of the fluid metal similar to that of a barometer; but the mercury slowly descended, thus proving that the air penetrated through the substance of the cell.

MINING BEES AND UPHOLSTERER BEES.

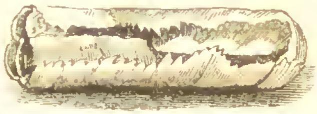
Several species of solitary bees are *miners.* They excavate cylindrical holes in the earth to the depth of five or six inches, and sometimes nearly a foot, and only of sufficient diameter to allow them to pass in and out freely. The most remarkable feature in their history is the patient industry with which they get through their work, for in making these tunnels they have to remove the earth almost grain by grain to the surface, where they collect it into a little heap.

Some of the mining bees prefer the hardest earth, or, at least, that which has been well rolled or trodden under foot. Garden walks from one end to the other are sometimes drilled with nearly perpendicular holes; but some species of bees form horizontal galleries in sand or gravel; while others prefer to work in ordinary earth. The sloping sides of roads often contain thousands of these holes; they may also be found at the edges of ditches and in mud walls.

None of these holes are pierced exactly in a right line, but are in most cases curved. In examining them it is desirable first to introduce a flexible stem or twig as far as it will go, to prevent the earth from falling in and filling up the hole. The insect bestows no particular care on the interior until she gets near the bottom, which is often made wider than the rest of the tunnel, and has its sides more smooth and uniform. Here the bee deposits a store of bee-bread and a single egg, which being done, she throws back into the hole the greater part of the earth which she had removed, for unless this were done, ants and other insects would soon discover and devour the store of sweets. M. Réaumur opened a nest which he had seen a miner bee excavating in the mortar of a garden wall, and found at the bottom a white worm very similar to the grub of other bees. It was resting upon a mass of bee-bread, of the colour and consistence of gamboge, which had a slight sugary taste and a somewhat narcotic odour. This grub was removed together with its provisions into a glass tube, but it died in a few days.

The species of mining bees are various. Some are smaller in size than the house fly, others are larger than the worker hive bee: between the two are several distinguished by long narrow bodies, others by short thick ones: the different species also vary considerably in colour. There are other species not included in this general enumeration, whose nests are far more complicated and artistic: they not only dig holes, and much larger ones than those just noticed, but in these holes they form nests for their young, with little cuttings of leaves most beautifully arranged, which has procured for them the name of *upholsterers.* Indeed, few insect performances are better adapted to give an idea of the skill which the Almighty has conferred upon some of the meanest of His creatures.

M. Réaumur, who had long heard a vague and general account of these nests, but had never seen them, had his curiosity unexpectedly gratified by the following odd incident. At the beginning of July, 1736, a large proprietor of a village near Andelis on the Seine, a few leagues from Rouen, paid a visit to the Abbé Nollet, accompanied by several of his domestics, among whom was a gardener, in whose face were evident marks of terror and alarm. This gardener had sought out his master, who happened to be in Paris, to inform him that some one had bewitched his garden, in proof of which he exhibited some curious rolls of leaves, which he could not doubt were made by the hands of a sorcerer, and by him deposited in the earth. On looking at the rolls, the master, thinking their appearance might be explained by natural causes, took them to his medical man, who was not able to account for them, but referred to M. Nollet, as an authority in matters relating to Natural History. On hearing the gardener's story, M. Nollet went to his cabinet and brought out several rolls of leaves, the production of some kind of beetle; he showed them to the gardener, and assured him they were made by insects, and that insects were doubtless the authors of the rolls which had caused so much alarm to himself and the people of his village. He then pulled to pieces one of the



rolls (which the gardener had looked upon with so much awe that he had not dared to open one), and a large grub immediately fell out. The gardener could not restrain his joy at having escaped from what he really thought was a great calamity. M. Nollet's only claim on his gratitude was to be allowed to retain the rolls he had brought, and to request him to collect a fresh supply, to pack them carefully in a small box, and send them by post to M. Réaumur, as soon as possible, all which the honest gardener faithfully performed.

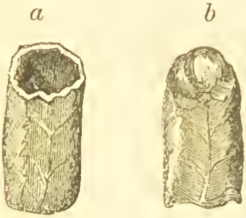
As soon as the visit was over, M. Nollet hastened to convey to M. Réaumur the nests which he so much desired to see. The first he opened contained a nymph, shrouded in a silken cocoon very much resembling that of a bee. On opening another, he found a small grub nestling upon a mass of bee-bread, which scarcely differed from that of the bees already noticed. The leaves employed in making these nests were those of the elm; but other species of leaf-cutting bees were afterwards discovered, which severally made use of the leaves of the rose-tree, the horse-chestnut, and several other trees and shrubs.

Each roll was found to consist of six or seven smaller rolls, also formed of leaves, placed end to end, and concealed under a common envelope of leaves. These smaller rolls are so many distinct cells, each destined to shelter a single worm from the time of its birth until it has attained the perfect insect form. Within the cell is also stored the bee-bread, which, although it contains a good deal of nearly liquid honey, is perfectly retained by this simple and beautiful arrangement of morsels of leaf. They are not fastened together by any kind of glue or cement, but being bent and accurately adjusted while yet green, they become rigid in drying, and are capable of holding honey in a fluid state. These little vases are very much like small thimbles, one end being closed, and presenting a rounded convex surface, while the other end is open. In examining a roll of these little cells it is found that the small end of the first cell fits into the large end of the second cell, and the small end of the second cell fits into the large end of the third, and so on to the sixth or seventh cell, which is retained in its place by the outer covering of leaves.

ROLL OF CELLS.

But in order to form an idea of the precision and skill with which these bees work, it is necessary to examine their nests more in detail. Each cell is formed of pieces of leaves, of similar or nearly similar figure. Each piece is about as long again as it is broad, and one end is considerably broader than the other. In the nests constructed by different species the cells differ in size, some being much larger than others, and of course requiring larger sections of leaves in their construction ; but even in

the same cell, of whatever size, these sections are made to differ in breadth; they are all of the same length, but some are narrower than others. When cut from the leaf all these pieces are flat, and they are curved by a process which will be explained presently. With these morsels of leaves the bee forms a cell, of which the interior diameter is about three lines, and the length about six lines, being one line shorter than the sections of the leaf, a portion to the extent of one line being folded in to help to form the bottom of the cell. Three similar and equal pieces of leaf are more than sufficient to form a hollow tube three lines in diameter; but the pieces are made to lap over each other, a portion of the first being concealed under the second, and a portion of the second being hidden by the third. The separate parts of the cell thus formed are retained in their places by the spring which the leaf acquires in drying, and the small portion doubled in at the base of each piece still further helps to retain the pieces in their position. The bee, however, is not satisfied with a cell formed of only three pieces of leaf, for she knows well enough that it would not retain the fluid portion of her bee-bread; she therefore strengthens this cell with three more pieces of leaf, curved like the first, and in like manner bent at their lower ends. This second layer of leaves forms a



CELLS OF THE LEAF-CUTTER BEE.

a, a cell with its mouth uppermost; *b*, a cell with its base uppermost.

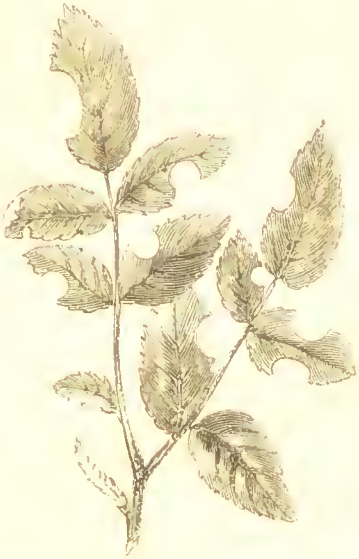
second tube contained within the first; but not yet satisfied with her work, the careful insect forms a third layer or tube within the second, so that nine pieces of leaf are employed to form one cell, and sometimes she even uses as many as twelve. In forming the second layer she takes narrower pieces than were employed for the first layer, and the pieces of the third layer are still narrower than those of the second. All have an equal or nearly equal length, and the ends of all the pieces are turned in to form the bottom of the cell; but the pieces of the innermost layer cover the centre more completely than those of the other two layers.

The cells are placed in a horizontal position, or nearly so, and as each one is completed, it is filled with bee-bread of a somewhat reddish colour, a sweetish acid taste, and a portion of it is fluid. When a cell is filled to within about half a line of the upper edge, the bee deposits a single egg in it, and then proceeds to stop up the opening before another cell is commenced. Her method of doing this is the simplest and best that could be chosen in working such apparently fragile materials as leaves; she cuts out a circular disk of leaf, and puts this into the entrance of the loaded cell, to which it forms a sort of lid or cover. From what has been already said, it will easily be understood that the interior of the cell is slightly conical, so that a circular disk, the diameter of which is but a trifle smaller than that of the cell at its entrance, would soon be stopped by the sides of the cell, to which it would form an excellent cover.

But the bee does not trust to one only of these circular plates; she uses three, and even four, placed one upon the other. They are in no way glued, but are held by closely fitting the part to which they are applied. These three or four little disks do not quite fill up the cell; there still remains a depth of about half a line, in which the bee adjusts the base of the next cell. In this way she completes a file of six or seven cells, which form a sort of roll or cylinder. This roll is then covered up with an envelope, which keeps the cells in their position, and preserves them from injury. The pieces of leaf forming the envelope are larger than those employed for the cells, and they are of an oval form. They are held in their places by nothing but the spring which they take in drying; the pieces near the two ends are carefully folded over, so as entirely to cover in the cells.

But by what means do the bees cut out these pieces, and give to each piece its required dimensions? M. Réaumur had long been unable to ascertain by what insect the leaves of his rose-trees had been cut; he had watched them day by day, and also at night with a lantern, but without success; he had also searched under the rose-trees for a nest, and could find none; but as soon as he had carefully examined the leaf-nests of our bees, and had compared the different shapes of the cuttings with the leaves of his rose-tree, he had no longer any doubt on the subject; some of the spaces left in the leaves of the rose-tree were oval, others nearly half oval, while a third set were circular; thus precisely agreeing with the forms of the pieces employed in the nest.

Thus knowing what to look for, and where to look for it, M. Réaumur visited his garden with enlightened eyes. On the following day, about noon, he saw a bee alight upon a shrub near the rose-tree, and after resting a few seconds, fly to the rose-tree itself. She placed herself beneath the leaf, and seizing the edge with her two mandibles, cut it, and continued to do so, advancing all the time towards the principal nervure; then bending round, she directed her course again towards the border, and finished her cutting not far from the place where she had commenced. Then bearing the piece

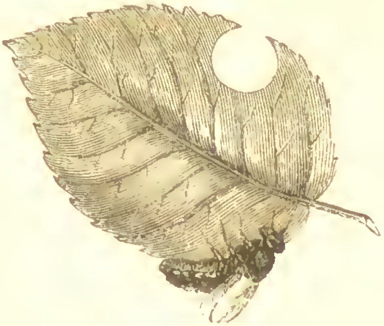


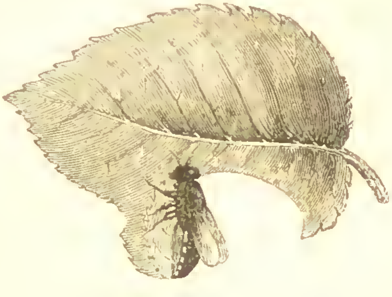
ROSE-LEAVES CUT BY BEES.

between her legs, she rose high in the air, and was soon out of sight. In this operation, her mandibles acted as well and as quickly as the best scissors would have done: indeed M. Réaumur doubts whether with good scissors he could have cut a similar piece out of a sheet of paper in the same time.

As the rose-leaf cutters had nearly completed their nests for this season, M. Réaumur was obliged to defer his observations for another year. In the following spring, when his rose-trees were out in the leaf, he cast an eye upon them every time he passed by, to see if any of the leaves had been cut. When he observed that they were cut, and that the number of cuttings increased daily, he began to watch, and was able during many days, in the latter part of the month of May, to study the proceedings of these interesting insects.

He found that, in general, when a bee arrives near the rose-tree, it does not immediately settle upon it, but flies about it several times, and often in different directions, as if to select some particular leaf. Having decided, she flies to the leaf selected, and seizing the edge between her mandibles, begins cutting the very moment she touches the leaf. They do not all settle on the leaf in the same manner. Some alight upon its upper surface; some upon its under surface; while others catch the edge at once with their mandibles, and begin cutting. Most of them seize it near the leaf-stalk, with the head turned towards the point of the leaf: but they sometimes settle near the point, and work with the head turned towards the leaf-stalk. Whatever their position, they all use their mandibles after the same fashion. The cuts are made with such rapidity that the eye cannot separate them: the notch rapidly increases in size, and the bee takes between her legs the edge of the partially severed portion. The direction of the cut is always that of a curve. The bee cuts precisely as if the pattern were marked out upon the leaf, walking upon the very part she has begun to detach, passing it between her legs, and continually pushing forward her mandibles. A fly walking in a straight line over a smooth surface could not move more quickly than our bee does in cutting a rose-leaf. She does not hesitate a moment: as she advances the piece hangs more and more; she curves her body, doubles the cutting between her legs, and at last, when in the very act of severing the cutting from the leaf, she begins to balance herself on her wings, and sets off to her


ROSE-LEAF CUTTER.
(At work.)


ROSE-LEAF CUTTER.
(In another position.)

nest with the piece of leaf folded between her legs.

In this way she severs and conveys to her nest all the required pieces, of which there are three varieties, namely, the oval, the semi-oval, and the circular. However regular may be the outline of these last, she bestows no extra time or attention in cutting them. The ease and precision with which she forms these disks are very surprising to us, who could not produce them without the aid of compasses. If the bee placed herself in the centre of the piece to be cut, and if, while her mandibles were cutting, she turned herself round upon some part of her body, as upon a pivot, she would in such case have something to guide her, which might serve the purpose of compasses; but instead of this, she occupies what appears to be the most disadvantageous position, namely, the circumference of the circular piece; and, in cutting, she is not able to see the portion which she cuts any more than that which remains to be cut, and yet there is no hesitation; she does her work as rapidly as we could cut a straight line of the same length in paper. But our admiration must not rest here. This circular piece is intended to close the end of a tube, which it must fit with sufficient exactness to prevent the fluid part of the bee-bread from escaping; the diameter of the disk must, therefore, be precisely equal to that of the tube. Whilst the bee is on the rose-leaf the cell which is to be closed is no longer before her eyes; it is some distance off, buried in the earth, so that she cannot fit and adjust this disk to the mouth of the cell, as we must do if we had a similar task to perform; and yet she knows precisely what diameter to give her disk, and cuts it out without a moment's hesitation, because she is taught of God, and therefore has her lesson perfect.

The pieces of leaf which compose the cells also require to be exact in their dimensions; they must be of equal length, larger at one end than at the other, and some pieces must be broader than others; and yet, without rule or measure, the bee cuts out her leaves to the required size! Some persons have contended that insects perform their tasks mechanically, just as some artizans by constant practice perform certain operations, almost without a thought. Without entering into this question we may say, with Réaumur, that if these rose-leaf cutters are machines, they are very surprising ones; but whether they perform their work mechanically or with the aid of mind, the glory is nevertheless due to the Supreme Intelligence, which has created both them and it.

It is not possible to watch a bee at work in her dark gallery, but it is still not difficult to trace her proceedings. Her first and most laborious task is to dig a gallery, or tunnel, of sufficient size to hold her nest. She makes this gallery of a cylindrical form, which is best adapted to mould her leaf-cuttings. Contrary to the usual method of proceeding, she forms first the outer covering of the cells before beginning the cells themselves. It will easily be seen that this is the only method by which the cells could be secured in an outer case, since the whole nest is made to fit with tolerable closeness in the earthy tunnel. The first pieces of leaves that she conveys are therefore the largest, or oval-shaped. When the bee arrives at the tunnel she still holds the piece of leaf folded in two; she opens it, inserts it into the cavity, and pressing it against the sides, makes it take a curved form. In this way she lines the cavity with two or three distinct layers of leaf, forming a sort of tube. In this she builds her cells, one after the other, arranging them in the manner already spoken of. It will easily be understood that, as the sides of the tunnel serve to curve each piece of the outer case, or envelope, so the sides of the envelope serve to curve the pieces which form each cell.

Although numbers of bees flew away every day with their leafy burdens, M. Réaumur could not discover their nests. About the middle of June, however, a leaf-cutter of a species different from those already noticed, enabled him to watch her movements with sufficient closeness to leave no doubt as to the mode of proceeding. While watching a bee, which was actively engaged in excavating a tunnel, our observer happened to raise his eyes in the direction of a stone terrace which was near, and saw a portion of a green leaf being pulled into a chink formed between two stones. On continuing to watch the chink, a bee was seen to fly out. It was of larger size, and redder than the rose-leaf cutters. She immediately flew to a young chestnut-tree, ten or twelve feet off, hovering about in the air as if to find a leaf to suit her purpose; she took several leaves between her mandibles, and left them before she settled upon one; but having found one to her mind, she cut out a large piece in a moment, and conveyed it to her hole, returning immediately to the same tree to get another cutting. She made more than twelve journeys in less than half an hour, bearing a piece of leaf each time, which was not always procured from the same tree, but sometimes from other young chestnut-trees near the first.

As none of the pieces which the bee had cut out were circular, and no circular marks appeared on the leaves of the chestnut-trees, M. Réaumur judged that the nest was only just begun, and that no cell had as yet been finished; he therefore determined to examine the work, to ascertain whether the bee really did commence with the outer case, or envelope, as he had supposed. The bee, now probably fatigued with her work, remained out longer than she had previously done, and returned without her leafy burden. Watching, therefore, the moment when she again quitted her nest, M. Réaumur removed the turf which covered the stones, and then carefully lifted up one of them. As soon as this was removed, the pieces of leaf were seen rolled up into a sort of tube, which partly sprang open as soon as the pressure of the stone was taken away; for the leaves had not yet had time to dry, and still retained their natural elasticity. This was evidently nothing but the outer case of the nest. M. Réaumur repaired, as well as he could, the damage he had done, and removed some of the loose earth which had fallen into the tube; he then carefully replaced the stone, and was about to put on the turf, when he saw the bee coming home. She entered the chink, but the moment she got into her nest, she hurried out again, doubtless quite amazed at the confusion which she found there; but soon taking courage, she returned, and began to repair the damage. Her first care was to remove the loose earth from the interior, which she did by pushing it out with her hind legs. She had been engaged in this work about two hours, when M. Réaumur was obliged to return to Paris, where he was detained two days. In the afternoon of the second day he returned to Charenton, expressly to see how the little leaf-cutter was getting on with her nest. Again he saw her enter the chink, without carrying any leaf; and he thought it probable that she was bringing in a supply of honey and pollen for one of the cells. She went out again, and remained out a long time, and returned also without any leaf. After she had gone out a third time, M. Réaumur

OUTER CASE OF NEST.

removed the stone, and saw the outer case now forming a horizontal tube, nearly five inches long. The leaves no longer flew apart, for, in drying they had taken a permanent bend. On introducing a piece of straw at the open end, it penetrated only about one-third of its length, the remaining two-thirds being evidently occupied with cells. There was still accommodation enough for two or three cells, which in fact were afterwards added. The stone was carefully put into its place; but when the mother returned, she was evidently aware that something had been done to her nest, for she flew away again in alarm; but gradually she took courage, as on the former occasion, and continued her operations as before.

The grub of the leaf-cutting bees is quite white. After it has consumed all its food, it spins a cocoon of silk, which is attached to the sides of the cell, and nearly fills it. The exterior of the cocoon is formed of a thick, coarse silk, of a coffee-brown colour; the interior consists of very fine whitish silk, as smooth and shining as satin. The cocoon requires to be strong, for these insects, either in the form of grub, nymph, or perfect fly, pass the whole of the winter in the nest, and their skin is exceedingly tender; therefore, should the leaves of the nest become damp and decay, the cocoon affords a warm, dry, and secure abode.

The leaf-cutting bee, in common with the other solitary bees which have been noticed, is liable to have her cells occupied by the grubs of other insects, which devour her own. While she is out collecting food, a stealthy foe deposits her eggs in the bee-bread. M. Réaumur has found a cell occupied by four or five cocoons, made by the grubs of a flesh-fly, after they had devoured the legitimate owner of the cell.

The history of the leaf-cutter bee has been so fully and so faithfully written by M. Réaumur, that little has been left for subsequent observers. Mr. Newport has, however, recently noticed a curious deviation from the usual habits of this insect. He says :—"On the morning of the 19th June, 1829, I observed one of these busy little creatures conveying alternately portions of rose-leaves, and of some other material, which, at first, I could not identify, to a hole in a brick wall in our garden, where she was constructing her nest. The whitened and singular appearance of this new material induced me to watch her proceedings, to ascertain its nature. The quantity conveyed by her was fully equal to that of the rose-leaves, and it seemed to be regarded by her with quite as much attention. On examining her proceedings very closely, which I had an opportunity of doing, as the nest was advanced towards the entrance of the hole, I was much amused at the precision with which she seemed to adjust her materials. On one occasion, after being for some time engaged in the hole, she came to the entrance for a few seconds, and seemed as if surveying the interior, then again proceeded to the bottom of the cell. After she had remained there for some time, she suddenly brought out a piece of the white material and dropped it on the outside of the nest, as if unfitted for her purpose, and then flew away, and in a few moments afterwards returned with a portion of rose-leaf. On examining the material rejected by her, I was surprised to find that it was a little piece of cotton cloth, very finely carded or picked to pieces, and which I at first supposed had been substituted for some other material usually employed by her. In the early part of the following day she had made good progress with her labour; I saw her at work very soon after four o'clock in the morning, when she was bringing in rose-leaves, and also cotton, as on the previous day, with great assiduity, and she continued to do so until about ten o'clock, after which I missed her for nearly two hours. At that time, I suspect she was engaged in the business of oviposition. The interior of the nest seemed then to have been nearly completed, and the hole was partially lined with cotton at its entrance. Soon after twelve o'clock I again saw her; she was then heavily laden with pollen. At one o'clock her activity was increased, and rose-leaves alone were then conveyed to the hole with great rapidity, and continued to be so until the nest was completed. At this stage of her labours, I carefully noted the length of time that elapsed from the moment of her leaving the nest to her return to it laden with rose-leaf, and was astonished to find that it never exceeded forty-five seconds, and very frequently not more than thirty seconds; although, (as I afterwards discovered the rose-bush, from which, from the direction of her flight, she seemed to have cut the leaves,) she must have flown at least a quarter of a furlong and back again, besides having to cut her material of its proper shape. Now if, we allow only one-third of the whole time to have been employed in cutting the leaf, which certainly is less than that usually occupied in this labour, her velocity of flight could never have been less than at the rate of a mile in six or seven minutes, and often in less than three minutes and fifty seconds.

"At three o'clock in the afternoon, her labour was completed. She had then closed up the entrance to the nest, and had also filled up part of the hole with rose-leaves. After taking a survey of the spot, she flew away, but in a few seconds returned, as if to press down the leaves a little closer, and then deliberately left the place, and proceeded in search of another hole in the same wall for a repetition of her labours.

"On the 17th July, twenty-seven days after the completion of the nest, I removed the bricks from the wall, for the purpose of examining it. On separating two bricks, between which the nest was built, I found that the hole extended in a horizontal direction, about five inches, and that it contained four cells, each of which was occupied by a full-grown larva, that was spinning a cocoon of brown silk, preparatory to changing to a nymph. But what now excited my admiration was the instinct exhibited by the parent in the construction of her nest. The base of the hole being full of cavities, and altogether uneven, the little architect had remedied these defects by filling them with the cotton she had been so actively conveying to the spot, until the interior of the hole presented an even surface, around which she then placed the rose-leaves, the materials usually employed by her. I could not help feeling that this was one of those admirable variations of instinct, which ought to make us hesitate when we are told that insects, and the higher order of invertebrated animals, are not endowed with faculties which approach somewhat closely to that of reason."*

TAPESTRY BEES.

The model on which the nests of the leaf-cutter bees are constructed has also been given to other species of Upholsterer bees, although they use their materials in a different manner. Those about to be noticed form their establishments in the mortar or mud of park and garden walls. Their nests form a sort of cylinder, consisting of several cells, placed horizontally, end to end. These cells are smaller than those of the leaf-cutters, one cell not exceeding four or five lines in length, and scarcely two lines in diameter. The number of cells in each nest is determined by the nature of the burrow. When the progress of the bee in excavating is stopped by a stone, she often contents herself with a burrow capable of holding only two cells; but she sometimes passes round the stone, and forms a curved tunnel.

A cylinder containing a number of cells, is marked by bands of two different colours; narrow white bands forming the junction of two cells; and larger bands of a reddish brown colour forming the body of each cell. This colour however, is liable to change, it being produced by that of the bee-bread contained within. The cells are formed of several layers of a thin transparent membrane resembling gold-beater's skin, through which the colour of the bee-bread appears; but, as the bottom of one cell fits into the upper part of another, the junction consists of a double set of folds, which conceals the colour of the bee-bread, and gives that of the membrane itself; thus accounting for the alternate bands. Each cell is stopped up by a loose piece of membrane, as shown in the figure.

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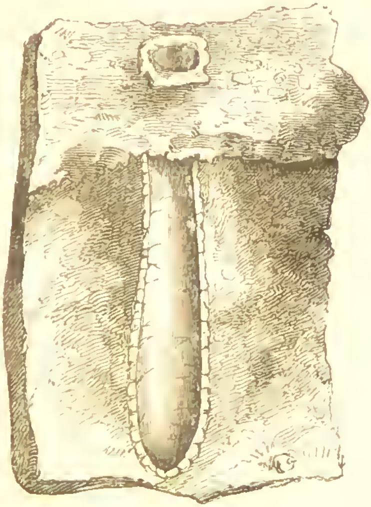
* Transactions of the Entomological Society of London, 1845.

The delicate membranes which form this little vase are supported by the bee-bread, which gives them solidity. When first introduced, this bread is nearly fluid, but it soon hardens, except a small portion, which is the first food of the grub after it is hatched. Then, as if aware of the weak state of the walls of its abode, the little insect consumes its food in a far more methodical manner than other grubs are known to do: it gradually opens a hole in the very centre of the bread, which hole, of course, increases in size daily; so that the sides of the cell are constantly supported by a tube of bread. This tube becomes thinner and thinner, but serves to support the edifice till the grub is ready to change its condition; and then the cocoon nearly fills up the whole of the cell.

M. Réaumur was unable to ascertain the source whence the bee obtained the membrane for her cells.

On examining it under the microscope, no fibrous or vegetable structure was apparent : it had a silky texture, but no silk-spinning apparatus could be detected in the body of the bee. This distinguished observer was, however, more fortunate in the case of another species of the tapestry bee, which we should be disposed to charge with indulging in luxurious habits, "if we had any proof that human vices are repeated in the lower animals." We convert our apartments into luxurious abodes by adorning and furnishing them with carpets and tapestries of various bright colours ; and this little bee does the same with the burrow which she forms in the earth ; she lines it throughout with brilliant scarlet hangings, extending them even on the



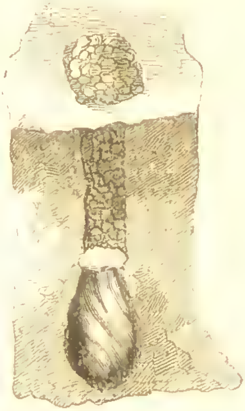
SECTION OF CELL.

surface of the ground round the margin of her abode. Her first care is to form a burrow in the earth, to the depth of about three inches. It is a perfect tube to within seven or eight lines of the bottom, below which it swells out a little. Having polished the walls of this little apartment, she visits a neighbouring field, cuts out an oval piece from the petals of the wild poppy, folds it between her legs, and returns with it to her burrow. When the flower is but half expanded the petals are wrinkled, but the little upholsterer knows how to smooth the folds, and to make each piece exactly fit the part to which it is to be applied, trimming and cutting off small portions when necessary. Each piece hardly covers a fifth or a sixth of the height of the cell, and not more than a third of its circumference; and not satisfied with one lining, she uses as many as three, and sometimes four distinct linings, varying the size of her cuttings in different parts of the cell, and also in the different layers. She begins each lining from the bottom, extending it up to the surface, and

POPPY FLOWER.

covering a portion of the margin on the outside. Having completed her hangings, the bee next lays in a stock of bee-bread, which is a reddish conserve of a sweetish sour taste, and then deposits a single egg. The egg and the bee-bread occupy the bottom of the apartment, to the height of about half an inch. She next detaches the poppy lining from the margin and sides of the cell, and giving it a slight twist, presses it down closely, folding it inwards upon the bee-bread, so as to form a cover, and then fills up with earth the remainder of the hole.

The great depth of the hole, compared with the space which the single egg and the accompanying food deposited in it occupy, deserves particular notice. The cell does not occupy more than half an inch at the bottom of the hole, the remaining two and a half inches being filled up with earth. Before M. Réaumur was aware of this fact, he was greatly puzzled to account for the disappearance of a number of nests, which he had observed in progress one evening, and had marked their positions by a stone or a twig placed near each. The next day they were no longer to be seen; the ground was smooth and even, and presented no appearance of having been excavated. On removing the surface to the depth of two inches, the nest was still not to be found. It then occurred

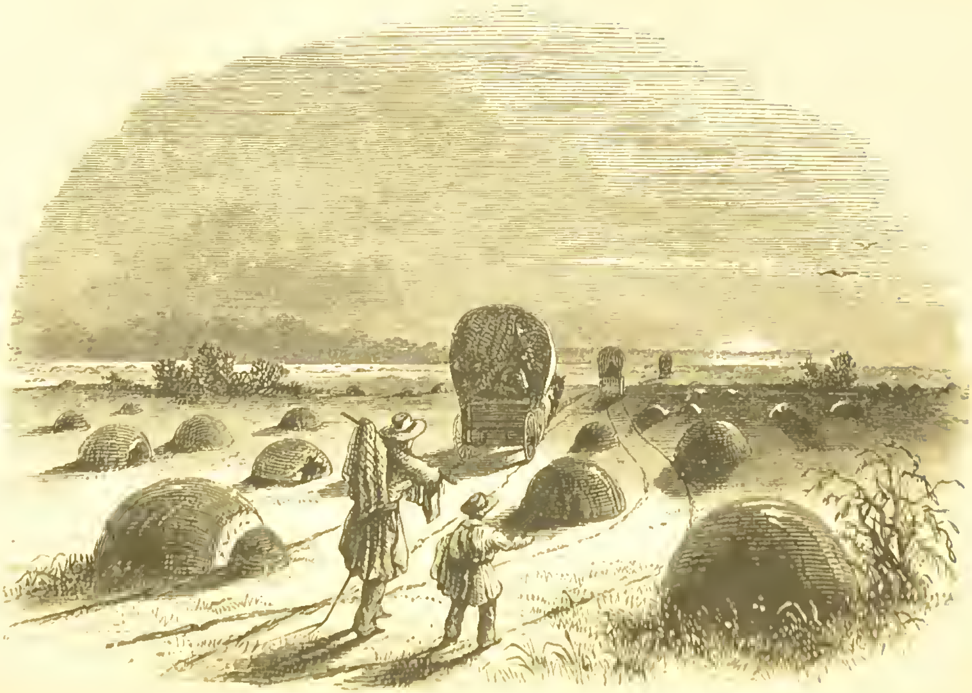


FINISHED CELL.
(Seen in Section.)

to him to go a little deeper, which he did, and found the nests he had marked. On opening several nests which he had marked ten days previously he found some of them occupied by a large white grub, which had consumed all its food, and was about to change its condition; others were not so fortunate, for they had died, leaving their food untouched.

These bees make their nests in bye-ways, especially in the paths which cross corn-fields. Although digging a hole, covering its walls with three or four layers of poppy-leaf, storing it with food, depositing an egg, taking the hangings down again to make a cover for the cell, and lastly, filling up the hole with earth, may seem to be an arduous task for the little insect which is represented here of the size of life, yet she is so good an economist of time, and so skilful a workwoman, that she completes the whole in two or three days; and as all this labour is required for each egg, and she has doubtless many eggs to lay in one season, some idea may be formed of the busy, active life of the tapestry bee.

And here we conclude our notice of bees in general. The reader can scarcely make the slight acquaintance with the history of the bee which these three sections are calculated to give without admitting that, whether as respects the hive bee, the humble bee, or the various species of solitary bees, *the bee as an example of economy* has been well selected.



ANT HILLS IN SOUTHERN AFRICA.

THE ANT,

AS AN EXAMPLE OF PRUDENCE.

PART I.

> "Go to the ant, thou sluggard; consider her ways, and be wise:
> Which, having no guide, overseer, or ruler,
> Provideth her meat in the summer, and gathereth her food in the harvest."—*Prov.* vi. 6—8.

THE inspired writer places the ant among the "four things which are little upon the earth, but exceeding wise;" (Prov. xxx. 24;) and it is the *wisdom* or *prudence* of the ant that we would especially bring into notice.

The value of prudence and good management is well understood among mankind; for these qualities apply to the every-day business of life, and are required for small as well as for great affairs. It was the remark of a shrewd observer, that he never heard a man complain of being unfortunate in his undertakings, but he immediately suspected him of being a very weak man in his affairs. Although there are many unforeseen circumstances, and heavy afflictions, which will at times overthrow the best-laid plans of human wisdom, yet the general course of events plainly shows that it is the good pleasure of the Almighty to bless the industrious and prudent man, and to give him a large share of what the world calls good fortune.

The value of prudence is so great, that without it even industry is of no avail. Many a person has passed through life in a sort of busy idleness, always in a hurry, yet never doing anything to good purpose, on account of the total absence of prudent management in the affairs on which he has been engaged. Thus, the thoughtless and the imprudent may learn, equally with the sluggard, a useful lesson from the history of the ant.

The labours and skilful management of ants are more remarkable in hot climates than in cold: the colonies are much larger and more numerous, and the whole proceedings of this busy people come more directly into notice, because you cannot often walk abroad, or even remain at home, without witnessing their activity. The admonition of Solomon, therefore, applies, in a very striking manner, to Eastern countries; and the more particularly, because some of the ants of those warm regions do actually lay up stores of provisions for the winter: whereas, in our own land, these insects become torpid in cold weather, and require no food.

But even here we can find sufficient to admire, and to yield instruction in the conduct of these little provident creatures; for we discover a constant active intelligence among their tribes, a careful economy of time, an attention to the state of the weather, with the view to make the most of every gleam of sunshine, a settled plan of action, subject only to such variations as the necessity of the moment may require, and a degree of wisdom and prudence in all their arrangements,—which is truly astonishing.

Nor may we affirm that the words of Solomon (as quoted at the head of these remarks) do not apply to our northern tribes of ants; for if we examine the words, they do not declare that the ant lays up food for the winter, although they would seem to imply that such is the case. The Rev. Mr. Kirby, speaking of this passage, remarks:—

"Solomon does not affirm that the ant, which he proposes to the sluggard as an example, laid up in her magazines stores of grain. 'Go to the ant, thou sluggard; consider her ways, and be wise: which having no guide, overseer, or ruler, provideth her meat in the summer, and gathereth her food in the harvest.' These words may very well be interpreted simply to mean that the ant, with commendable prudence and foresight, makes use of the proper seasons to collect a supply of provisions sufficient for her purposes. There is not a word implying that she stores up grain or other provision. She prepares her bread, and gathers her food, namely, such food as is suited to her—in summer and harvest—that is, when it is most plentiful; and thus shows her wisdom and prudence by using the advantages offered to her. The words thus interpreted, which they may be without any violence, will apply to our European species as well as to those that are not indigenous."

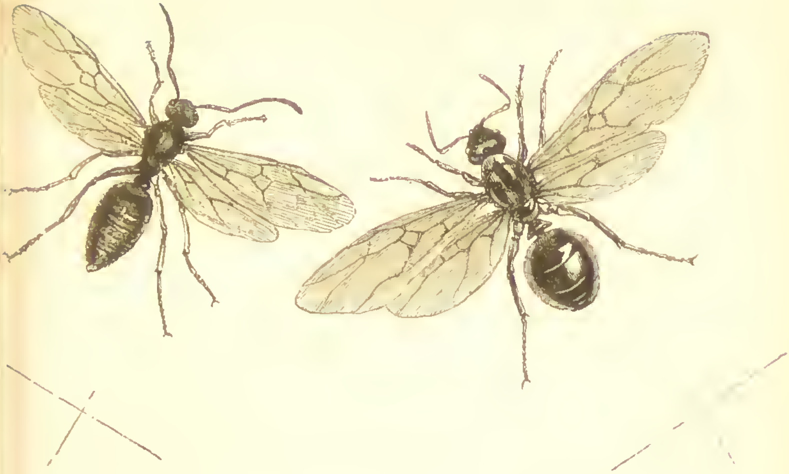
Dismissing all that is fabulous, or even doubtful, in the history of the ant, there remains much to be said of this insect that is both astonishing and instructive. The form of the ant, or emmet, is familiar to most persons: to those who are unacquainted with it, the enlarged representations of the three states of the red ant, given on the opposite page will be a sufficient description.

A colony of ants consists of males, females, and workers, besides eggs, larvæ, and pupæ. When the males and females first appear, they are furnished with four delicate transparent wings: the workers, or *neuters*, as they are sometimes called, have no wings. Their chief employment is to nurse the rising generation of the colony, to provide them with food, to shelter them from cold and wet, and to build nurseries for their accommodation.

The ant belongs to an order of insects called *Hymenoptera*, that is, having four membranous and finely-veined wings. The ant family is named *Formicidæ*, from the Latin word *formica*, an ant. There are many British species, the largest of which is the fallow ant (*Formica rufa*), also called the horse-ant, or wood-ant; there is also the turf-ant (*F. Cæspitum*), the yellow-ant (*F. flava*), the fuliginous or jet-ant (*F. fuliginosa*), and some others. The foreign species are very numerous.

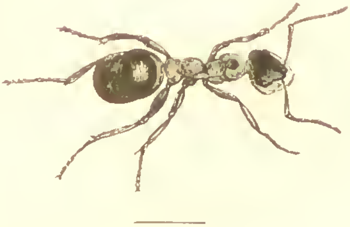
The first formation of a colony of ants has been described by M. Huber the younger, the excellent modern historian of this interesting insect. He says:—

"Let us visit a meadow on a fine summer's day, at a time when the ants first make use of their wings,



MALE.

FEMALE.



WORKER.

THE RED ANT.—(*Formica rufa.*)

(The lines under each figure show the actual size of the insect.)

and take a survey of their habitation, on the surface of which we shall observe, walking to and fro, many of its winged inhabitants. These are the males and females of the field-ant. They climb all the plants which surround their residence, and are everywhere accompanied by a multitude of workers, who follow their steps with ceaseless solicitude. Some, however, attempt to retain and reconduct them to the ant-hill; but the greater part content themselves with simply escorting them. They offer them nourishment for the last time, and render them the last token of their care and affection. . . . Disorder and agitation are now manifest in the ant-hill; the bustle increases every moment; the winged insects climb, with alacrity, the adjacent plants, followed by a numerous train of workers, who are continually running from

ANTS PREPARING FOR FLIGHT.

one male to another, touching them with their antennæ, and offering them food. The males at length quit the paternal roof, and take flight as from one general impulse, in which they are quickly followed by the females. The winged tribe soon disappears. The workers retrace, for some instants, the steps of these highly-favoured beings, to whom they have shown such extreme care and attention, and whom they are never destined to see again. . . . When the weather is favourable, (not below 67° Fahrenheit,) the labourers, who seem to be aware of it, form several apertures in the ant-hill, to give ready passage to the crowd that are about to quit it. The males and females may be then seen coming to take air at the entrance. The hour of departure arrives; they all take flight; the workers alone re-enter the nest, and close the entrances."

Messrs. Kirby and Spence have also described the swarming of ants in animated and eloquent terms, of which the following is an abridged account:—

"In the warm days that occur from the end of July to the beginning of September, and sometimes later, the habitations of the various species of ants may be seen to swarm with winged insects, which are the males and females, preparing to quit for ever the scene of their nativity and education. Everything is in motion, and the silver wings, contrasted with the jet bodies which compose the animated mass, add a degree of splendour to the interesting scene. The bustle increases, till at length the males rise, as it were by one general impulse, into the air, and the females accompany them. The whole swarm ultimately rises and falls, with a slow movement, to the height of about ten feet, the males flying obliquely, with a rapid zig-zag motion, and the females, though they follow the general movement of the column, appearing suspended in the air like balloons, seemingly with no individual motion, and having their heads turned towards the wind. Sometimes the swarms of a whole district unite their infinite myriads, and, seen at a distance, produce an effect resembling the flashing of an aurora borealis. Rising with incredible velocity in distinct columns, they soar above the clouds. Each column looks like a kind of slender net-work, and has a tremulous, undulating motion, which has been observed to be produced by the regular alternate rising and falling just alluded to. The noise emitted by myriads and myriads of these creatures does not exceed the hum of a single wasp. The slightest zephyr disperses them; and if, in their progress, they chance to be over your head, if you walk slowly on they will accompany you, and regulate their motions by yours." After sporting about in the air for some time, the males disappear, probably dying, as do the males of bees and other insects; for the workers never take any notice of them after leaving the ant-hill, and they are quite defenceless, having no sting, and no mandibles to provide for their subsistence. They, and many of the females, become the prey of numerous enemies, such as birds, spiders, and fish. Immense numbers are driven into rivers either by wind or rain. Dr. Bromley, when he was surgeon of the *Clorinde*, relates that, in September, 1814, being in the Medway, his attention was directed to a black appearance on the water, as of something floating down with the tide. "On looking with a glass," he says, "I discovered they were insects. The boat was sent, and brought a bucket full of them on board; they proved to be a large species of ant, and extended from the upper part of Salt-pan reach out towards the Great Nore, a distance of five or six miles. The column appeared to be in breadth eight or ten feet, and in height about six inches, which I suppose must have been from their resting one upon another." It was not ascertained from whence this immense column proceeded, but from the numbers collected, it would scarcely appear possible for all the ant-hills of Kent and Surrey to have furnished so many male and female ants.

The females that escape the elements, and their numerous enemies, become the founders of a new colony, building the nest, and doing all the work; but they are generally found by workers, who pull off their wings, and provide accommodation for them until they are ready to lay their eggs.

The labours of the working ants are most persevering, and furnish a remarkable example of insect industry. These commence with the formation of a nest, of which there are several varieties, according to the species; but all of them are highly ingenious, and merit a close attention.

Exceedingly curious is the nest of the *mason-ants*, which dig into the ground, and form structures with pellets of moistened loam, clay, or sand. On the outside the nest is a mere hillock of earth, but within it presents a series of passages, lodges, vaults, and galleries. A slight inspection of a perfect nest will show that the habitations of the different species are not all constructed after the same system. Thus, the ash-coloured ants always raise thick walls of coarse earth, well-marked stories, and large chambers, with vaulted ceilings, resting upon a solid base. They do not make roads or galleries, properly so called, but large passages of an oval form, with cavities and extensive embankments of earth. The little architects also observe a certain proportion between the arched ceilings and the pillars that are to support them.

The brown ant *(Formica brunnea)*, one of the smallest of the ants, is remarkable for the extreme finish of its work. Its body is of a reddish shining brown, its head a little deeper, and the antennæ and feet a little lighter in colour. This ant, one of the most industrious of its tribe, forms its nest in stories, about one-third of an inch in height. The partitions are very thin, but so well finished that the inner walls present one smooth, unbroken surface. These stories follow the slope of the ant-hill, and lie one upon another to the ground-floor, which communicates with the subterranean lodges. These ants do not follow an invariable plan in their building, but are able to modify it according to circumstances: their habitations are, however, always formed by concentric stories. In each story is a number of cavities or halls, lodges of narrower dimensions, and long galleries which serve for general communication. The arched ceilings covering the most spacious places are supported either by little columns, slender walls, or regular buttresses. There are also chambers that have but one entrance, communicating with the lower story, and large open spaces, serving as a kind of cross-road, in which all the streets terminate. The ant-hill contains sometimes more than twenty stories in its upper portion, and at least as many under the surface of the ground. By this management the ants can easily regulate the heat of their dwelling. When a too burning sun overheats their upper apartments, they withdraw their little ones to the bottom of the ant-hill. The ground-floor becoming, in its turn, uninhabitable during the rainy season, the ants of this species transport what most interests them to the higher stories.

The actual mode of working employed by these insects has been closely examined and fully described by M. Huber. He continued to watch an ant-hill, until he perceived a change in its form. The ants kept within during the day, or only went out by subterranean galleries, which opened at some feet distance in the meadows. There were two or three small openings on the surface of the nest, but none of the labourers were seen to pass out that way, on account of their being too much exposed to the sun, which these insects greatly dread. This ant-hill, which had a round form, rose in the grass at the border of a path. When the freshness of the air and the dew invited the ants to walk over the surface of their nest, they soon began to make new apertures; several ants might be seen arriving at the same time, thrusting their heads from the entrances, moving about their antennæ, and then venturing forth to visit the neighbourhood. At length, during a gentle rain, they began to build in earnest, and all their architectural talents were seen in full play.

As soon as the rain commenced, great numbers of them quitted their under-ground abode, re-entered it almost immediately, and then returned, bearing between their teeth pellets of earth, which they deposited on the roof of their nest. These were the foundations of little walls, which soon started up on all sides, having spaces left between them. In several places, columns, ranged at regular distances, announced halls, lodges, and passages, which the ants proposed establishing; in a word, it was the rough beginning of a new story.

Each ant formed the pellet of earth by scraping with the end of its mandibles the bottom of its abode. This little mass of earth being composed of particles but just united, could be readily kneaded and moulded at will: thus, when they had applied it to the spot where it was to remain, they divided and pressed against it with their teeth, so as to fill up the little inequalities of their wall. The antennæ followed all their movements, passing over each particle of earth as soon as it was placed in its proper position: the whole was then rendered more compact by pressing it lightly with the fore-feet. This work went on remarkably fast. After having traced out the plan of their masonry, in laying here and there foundations for the pillars and partitions they were about to erect, they raised them gradually higher, by adding fresh materials. In making a gallery, two little walls were raised opposite, and at a slight distance from each other; and when at the height of four or five lines the space between them was covered in by a vaulted ceiling.

The partitions being of a sufficient height, the ants quitted their labours in the upper part of the building; they then affixed to the interior and upper part of each wall fragments of moistened earth, in an almost horizontal direction, and in such a way as to form a ledge, which, by being extended, could be made to join a similar ledge coming from the opposite wall. On one side several vertical partitions were seen to form the scaffolding of a ledge, which communicated with several corridors, by apertures formed in the masonry; on another side a regularly-formed hall was constructed, the vaulted ceiling of which was sustained by numerous pillars; farther off, again, might be recognised the rudiments of one of those cross-roads, before noticed, in which several avenues terminate. These parts of the ant-hill were the most spacious; the ants, however, did not appear embarrassed in constructing the ceiling to cover them in, although they were often more than two inches in breadth. They laid the foundations of this ceiling in the upper part of the angles formed by the different walls, and from the top of each pillar, as from so many centres, a layer of earth, horizontal and slightly convex, was carried forward to meet the several portions coming from different points of the large public thoroughfare.

It would appear, at first view, that these ceilings, supported only by a few pillars, must fall to ruin under the rain, which continually dropped upon them: the earth, however, adhered on the slightest contact, and the rain, so far from loosening its particles, appeared to bind them together; indeed, rain is necessary to these little builders, to cement their work, and to smooth down all inequalities: the heat of the sun then consolidates the whole. A very violent rain will, indeed, sometimes destroy the apartments; but the ants re-construct them with wonderful patience.

These little masons work with much diligence. The ant-hill observed by M. Huber, received an additional story in the course of seven or eight hours. Scarcely had the ants finished one story, than they began to construct another; but they had not time to finish it, the rain ceasing before the ceiling was fully completed. They still, however, continued their work for a few hours, taking advantage of the humidity of the earth; but a keen north wind soon sprung up, and hastily dried the collected fragments, which, no longer possessing the same adherence, readily fell into powder. The ants, finding their efforts ineffectual, were at length discouraged, and abandoned their employment; but they first deliberately set to work to destroy all the apartments that were yet uncovered, scattering here and there over the last story the materials of which they had been composed. Thus it would appear, that they employ neither gum, nor any kind of cement, to bind together the several substances of their nest; but in place of this, avail themselves of the rain to work or knead the earth, leaving the sun and wind to dry and consolidate it. M. Huber soon found that when the ants suspended their labours for want of rain, he could always excite them to work, by dipping a brush in water, and passing the hand backwards and forwards over the hairs, so as to produce a fine artificial shower.

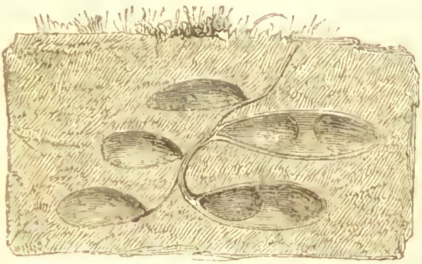
Most of the processes adopted by the ants in building were witnessed by M. Huber, in a glazed artificial hive or *formicary*, such as is presented in the following cut.

M. HUBER'S FORMICARY FOR MASON ANTS.

The ants seem to work each one for itself, without always attending to the labours of the other workers; consequently, the walls and arches do not always coincide, in which case they have to undo a portion of their work. M. Huber relates that the ants had erected a wall for the purpose of sustaining a vaulted ceiling, still incomplete, that had been projected towards the wall of the opposite chamber. The worker which began constructing it had not raised it high enough to meet the opposite partition, upon which it was to rest. Had it been continued on the original plan, it must have met the wall at about one-half of its height, and this it was necessary to avoid. "This state of things very forcibly claimed my attention, when one of the ants, arriving at the place, and visiting the works, appeared to be struck by the difficulty which presented itself; but this it immediately got over, by taking down the ceiling and raising the wall upon which it rested. It then, in my presence, constructed a new ceiling with the fragments of the former one."

When the ants commence any undertaking, they seem to work upon some preconceived idea. For example, should any ant discover upon the nest two stalks of plants lying crosswise, an arrangement favourable to the construction of a lodge, or some little beams that may be useful in forming its angles and sides, it examines the several parts with attention, then distributes with much sagacity and address parcels of earth in the spaces and along the stems, taking from every quarter materials adapted to its object, sometimes not caring to destroy the work that others had commenced; so much are its motions regulated by the idea it has conceived, and upon which it acts. It goes and returns until the plan is sufficiently understood by its companions. In an ant-hill M. Huber once noticed several fragments of straw, conveniently placed for forming the roof of a large house, being in a sort of oblong shape, at the distance of about half an inch from the ground. One of the workers, noticing this arrangement, began to place earth in the several angles of this frame-work, and all along the little beams of which it was composed. He then placed several rows of the same materials against each other, when the roof became very distinct. Seeing another plant fit to support a vertical wall, he began laying the foundations of it; other ants having by this time arrived, they finished in common what the first had commenced.

The following figure represents a vertical section of a mason-ant's nest opened by Mr. Rennie. It was situated at the edge of a garden-walk, and consisted of two stories, composed of large chambers irregularly oval, communicating with each other by arched galleries, the walls of all which were as smooth as if they had been passed over by a plasterer's trowel.



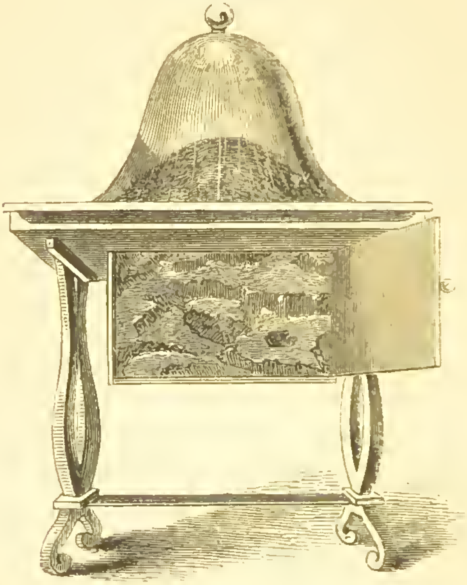
NEST OF MASON-ANT.
(Vertical Section.)

The wood-ant, or pismire *(F. rufa)*, builds a nest somewhat similar in shape to that of the hill-building species, but of different materials. This ant is easily distinguished from other species by the dusky black colour of its head and hinder parts, and the rusty brown of its middle. The outside of the nest is composed of whatever materials the colonists can convey to it, such as little bits of stubble, wood, leaves, small pebbles, and shells; wheat, oats, and barley have also been found on the heap, which has given rise to the notion that ants store up grain as food, whereas it is used simply to increase the height of the heap, that the rain may run off as from the roof of a thatched cottage. The roof, however, forms but a small portion of the nest, which consists of a great number of interior chambers and galleries, with funnel-shaped passages leading to them.

The wood-ants, having fewer enemies to fear than the ants which have not the shade and protection of trees, do not construct long covered ways to their nests, as the yellow and brown ants do. On the contrary, they prefer to live in the open air, and are quite indifferent as to the presence of a spectator, continuing to carry their loads, and, if teased with the finger, turning round with open jaws, ready to defend themselves. The nest of these insects is, at first, simply a cavity in the earth. Some of its future inhabitants are then seen wandering about in search of materials for the exterior work, with which they cover up the entrance, whilst others are employed in mixing the earth that has been thrown up in hollowing the interior with fragments of wood and leaves, which are every moment brought in by their assistants; and this gives a certain consistence to the edifice, which increases in size daily. Our little architects leave here and there small openings, where they intend to make the galleries which are to lead to the exterior. The roof soon becomes convex, but it is by no means solid, for it is destined to include many apartments or stories. The under portion of the edifice is mined or excavated into spacious halls, low, indeed, and of heavy construction, yet sufficiently convenient for their intended use, that of receiving, at certain hours of the day, the larvæ and pupæ. These halls have a free communication by galleries made in the same manner. The materials of the ant-hill are prevented from falling into a confused heap by the earth being tempered with rain-water, which afterwards hardens in the sun, and completely and effectually binds together the several substances, so as to permit the removal of certain fragments of the ant-hill without any injury to the rest; it, moreover, strongly opposes the entrance of rain. Even after long and violent rains the interior of the nest is seldom wetted to more than a quarter of an inch from the surface, provided it has not been previously out of repair, or deserted by its inhabitants. The ants are well sheltered in their chambers, the largest of which is placed nearly in the centre of the building: it is much loftier than the rest, and traversed only by the beams that support the ceiling; it is in this spot that all the galleries terminate, and this forms their chief residence.

The underground portion can only be seen when the ant-hill is placed on sloping ground; all the interior may then be readily inspected by simply raising the straw roof. The subterranean residence consists of a range of apartments excavated in the earth, taking a horizontal direction.

During the day the wood-ants are either foraging in the vicinity, or employed on the outside of their nest: at night their proceedings are very remarkable. Like prudent housekeepers, these insects actually close up and bar their doors before they go to rest. Towards evening their habitations change in appearance hourly, and the diameter of spacious avenues, where many ants could freely pass each other during the day, is, as night approaches, gradually lessened.



M. HUBER'S FORMICARY FOR WOOD-ANTS.

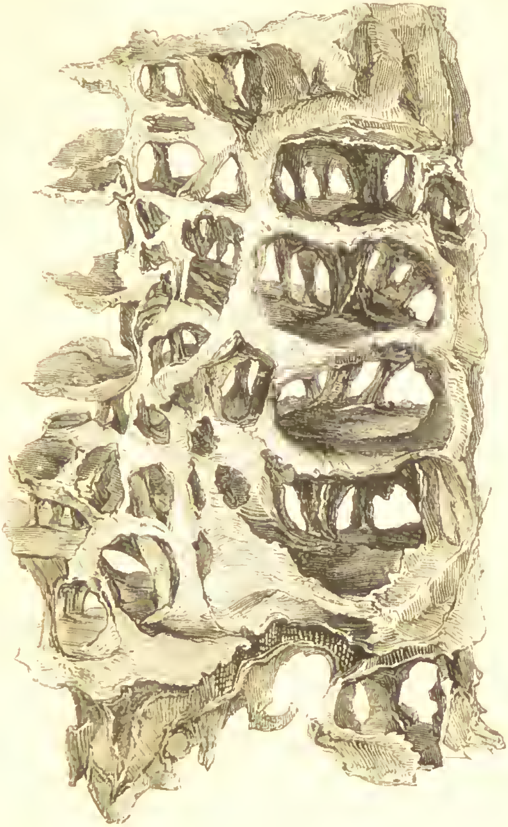
The apertures at length totally disappear, the dome is closed on all sides, and the ants retire to the bottom of their nest.

Huber, who watched this process closely, describes it thus:—

"I saw clearly that they were engaged in stopping up passages, and, for this purpose, they at first brought forward little pieces of wood, which they deposited near the entrance of those avenues they wished to close; they placed them in the stubble; they then went to seek other twigs and fragments of wood, which they disposed above the first, but in a different direction, and appeared to choose pieces of less size in proportion as the work advanced. They at length brought in a number of dried leaves, and other materials of an enlarged form, with which they covered the roof. Our little insects, now in safety in their nest, retire gradually to the interior before the last passages are closed; one or two only remain without, or concealed behind the doors, on guard, while the rest either take their repose, or engage in different occupations, in the most perfect security. I was impatient to know what took place in the morning upon these ant-hills, and therefore visited them at an early hour. I found them in the same state in which I had left them the preceding evening. A few ants were wandering about on the surface of the nest, some others issued from time to time from under the margin of their little roofs formed at the entrance of the galleries: others afterwards came forth, who began removing the wooden bars that blockaded the entrance. This labour occupied them several hours. The passages were at length free, and the materials with which they had been closed scattered here and there over the ant-hill. Every day, morning and evening, during the fine weather, I was witness to similar proceedings. On rainy days the doors of all the ant-hills remained closed. When the sky was cloudy in the morning, or rain was indicated, the ants, who seemed to be aware of it, opened but in part their several avenues, and immediately closed them when the rain commenced."

There are several species of ants which form extensive galleries and chambers within the trunks of trees, on which account they are called *carpenter-ants.* The most important of these is the emmet, or jet-ant *(F. fuliginosa)*, which is rather smaller in size than the wood-ant, and is of a fine shining black colour.

The labourers of this species are of much more retired habits than the ants already noticed; they work in the interior of trees, where they cannot be observed. All Huber's efforts to accustom them to live and work under his inspection were unsuccessful; they spurned the honey and sugar which he offered them, and even abandoned their nest to seek a new abode on his persisting to watch their operations. On examining their edifices, this distinguished observer found, on one side, horizontal galleries, hidden, in great part, by the walls, which follow the circular direction of the layers of the wood; and, on another side, parallel galleries, separated by extremely thin partitions, communicating by a few oval apertures. Sometimes these galleries appear like halls, supported by rows of pillars ; they rise story above story, presenting a light and delicate specimen of carved wood-work ;



CHAMBERS AND GALLERIES OF THE CARPENTER-ANT.

the whole tinged of a black colour, in consequence either of exposure to the air, or to the action of formic acid (a peculiar acid secretion found in ants).

The foregoing is a representation, copied from Huber's work, of a portion of a tree, with chambers and galleries chiselled out by these little carpenters.

These ants build also in the large roots of trees, but not in such regular stories as those in the body of the tree, arising probably from the hardness and interlacing of the fibres, which renders the labour more difficult. The carving, however, is more delicate, for the ants take advantage of the hardness and solidity of the materials to give their building an extreme degree of lightness.

"I have seen," says Huber, "fragments of from eight to ten inches in length, and of equal height, formed of wood as thin as paper, containing a number of apartments, and presenting the most singular appearance. At the entrance of these apartments, worked out with so much care, are very considerable openings; but, in place of chambers and extensive galleries, the layers of the wood are hewn in arcades, allowing the ants a free passage in every direction. These may be regarded as the gates or vestibules conducting to the several lodges."

Our space will not allow of detailed notices of any of the numerous species of ants which inhabit the warmer regions of the globe. Mr. Darwin says, that "a person, on first entering a tropical forest, is astonished at the labours of the ants; well-beaten paths branch off in every direction, on which an army of never-failing foragers may be seen, some going forth and others returning, burdened with pieces of green leaf, often larger than their own bodies. A small, dark-coloured species sometimes migrates in countless numbers. One day," he adds, "at Bahia, my attention was drawn by observing many spiders, cockroaches, and other insects, and some lizards, rushing in the greatest agitation across a bare piece of ground. A little way behind, every stalk and leaf was blackened by a small ant. The swarm, having crossed the bare space, divided itself, and descended an old wall. By this means many insects were fairly inclosed, and the efforts which the poor little creatures made to extricate themselves from such a death were wonderful. When the ants came to the road they changed their course, and in narrow files reascended the wall. Having placed a small stone so as to intercept one of the lines, the whole body attacked it, and then immediately retired. Shortly afterwards another body came to the charge, and again having failed to make any impression, this line of march was entirely given up. By going an inch round the file might have avoided the stone, and this doubtless would have happened if it had been originally there; but, having been attacked, the lion-hearted little warriors scorned the idea of yielding."

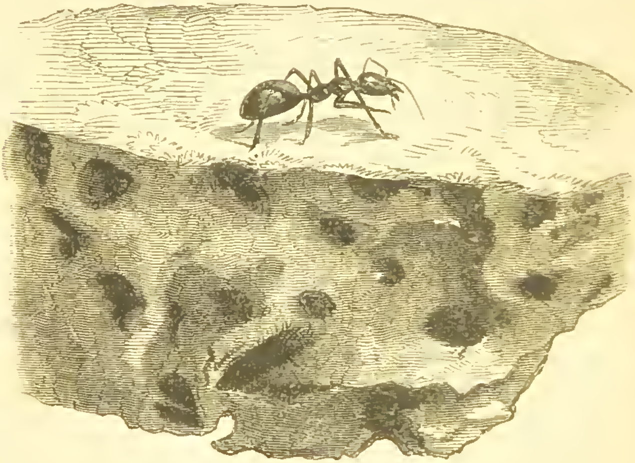
The size of some of the ant-hills in warm countries is astonishing. Malouet saw in Guyana ant-hills from fifteen to twenty feet in height, and from thirty to forty feet in circumference at the base; but he was afraid of approaching them within forty paces, for fear of being devoured. Stedman notices an ants' nest in Surinam, six feet in height, and one hundred in circumference. Dampier describes a small yellow ant of South America, which makes nests in great trees, one nest often of the size of a hogshead. Hawkesworth, in his account of Cook's first voyage, describes a species of ant in Australia, which builds a curious nest in trees, by bending down several leaves so as to form a kind of purse. Their method of doing this "we had no opportunity to observe; but we saw thousands uniting all their strength to hold them in this position, while other busy multitudes were employed within in applying the gluten that was to prevent their returning back. To satisfy ourselves that the leaves were bent and held down by the efforts of these diminutive artificers, we disturbed them in their work; and as soon as they were driven from their stations, the leaves on which they were employed sprang up with a force much greater than we could have thought them able to conquer by any combination of their strength; but though we gratified our curiosity at their expense, the injury did not go unrevenged, for thousands immediately threw themselves upon us, and gave us intolerable pain with their stings, especially those which took possession of our necks and hair, whence they were not easily driven."

With regard to the stings of ants, it may be remarked, that, in Britain, the ants are nearly harmless. In warmer countries, however, both the sting and the bite are very painful. The bite of the ant noticed by Dampier resembles that produced by a spark of fire; the insect is therefore called the *fire-ant*. Captain Stedman relates that this caused his soldiers to jump about as if scalded with boiling water, and the nests were so numerous that it was not easy to avoid them. The attacks of another kind of ant, mentioned by Madame Merian, are so alarming, that if they enter a house in the night, the inhabitants are obliged to rise with all speed and run off. This insect is called *the ant of visitation.*

Mr. Burchell notices the ants of the Southern Africa. Being anxious to make a drawing of a tree, he could not find a single yard of ground that did not swarm with large black ants. "It was therefore impossible to sit down, and nearly so to stand; for these troublesome insects, ever on the search for something to eat, soon found their way over my shoe, and seemed uncommonly delighted at feasting on a white man's leg—a treat most likely, till now, quite unknown to the little tribe—and, in spite of all my endeavours, they were determined not to let go their prize. Their bite, though not leaving behind it any inflammation, was yet exceedingly sharp at the moment, and kept me in continual motion to brush them off."

A few days after, in passing over one of the boundless plains of this country, the evenness of the surface was interrupted by innumerable ant-hills, of large size. They were of a rounded conical form, and so hard and firm as to bear the weight of a man, yet the wheels of a loaded wagon easily cut through them. "Sometimes, however, they are found to resist even this weight, and in such cases are carefully avoided, to prevent an overturn. This hardness is perhaps owing rather to the nature of the soil, than to a different species of insect. The height of the hillocks was generally from two to three feet, but higher were not unfrequently seen. Their structure was irregularly cellular, and not unlike a volcanic honeycomb-stone ; or rather consisted of perforations or passages, opening into each other, without any apparently methodical plan."

The frontispiece at p. 146 will give an idea of the appearance of these ant-hills, and the picturesque effect of journeying over a country without roads, and the deep track of the wagon-wheels over an untravelled soil. It will be seen that the wheel of one of the wagons has cut through one of the ant-hills. Two on the left have been plundered by that curious animal the ant-eater, which scratches holes in



WORKER ANT, AND PORTION OF ANT-HILL, IN SOUTHERN AFRICA.

the hillocks in order to disturb and get at the ants. The foregoing cut represents a portion of one of the hillocks, and a worker ant of the size of life.

Having described the nests of the mason-ants, the wood-ants, and the carpenter-ants, we pass on to consider their domestic economy, which is quite as admirable as their structures. The principal object of all the labours of this busy insect world is to train up a numerous and growing population, which requires constant care and attention ; and the affection of the workers towards the helpless objects committed to their charge is indeed worthy of notice. " The most determined despiser of insects and their concerns—he who never deigned to open his eyes to any other part of their economy—must yet have observed, even in spite of himself, the remarkable attachment which the inhabitants of a disturbed nest of ants manifest towards certain small, white, oblong bodies, with which it is usually stored. He must have perceived that the ants are much less intently occupied with providing for their own safety than in carrying off these little bodies to a place of security. To effect this purpose, the whole community is in motion, and no danger can divert them from attempting its accomplishment. An observer having cut an ant in two, the poor mutilated animal did not relax in its affectionate exertions. With that half of the body to which the head remained attached, it contrived, previously to expiring, to carry off ten of these white masses into the interior of the nest ! You will readily divine that these attractive objects are the young of the ants, in one of the first or imperfect states; they are, in fact, not the eggs, as they are vulgarly called, but the pupæ, which the working ants tend with the most patient assiduity."*

The queen-ant supplies the whole of the eggs, and lays them in various parts of the nest. These eggs, which are at first so small as to be scarcely visible, are taken by the workers into their mouths in small parcels, where they turn them backwards and forwards, for the purpose of moistening them, without which they would come to nothing. They then arrange them in heaps, in separate apartments, and constantly watch them until hatched into larvæ, frequently removing them from one part of the nest to another, as they require a warmer or cooler, a moister or drier air, and occasionally brooding over them, as if to warm them.

As in the case of the beehive, the temperature of the ant's nest varies according to circumstances, as appears from some interesting observations of Mr. Newport. In the month of July the temperature of the atmosphere in the shade, at eleven o'clock A.M. was 76° Fahr., and the mercury rose to 95° when exposed on the ground to the full rays of the sun. When the thermometer was first plunged into the nest to a depth of five inches, the temperature remained steadily at 84°; but within six or eight minutes afterwards, when the insects had become excited by the presence of the thermometer, and were running about in every direction, in a state of the greatest agitation, the temperature of the nest rose to 93°, and in a few minutes after this, when the insects were still more excited, to 95½°, and a little nearer the surface, where the commotion was greatest, to 98½°. During these observations, the ant-hill was carefully shaded from the rays of the sun; but when again exposed to its influence, the thermometer placed on its surface rose to 108°. This was a temperature much too great for the insects to bear, since nearly the whole of them immediately retired beneath the covering of the nest, and scarcely a single ant was to be seen. On the 2d September the observations were repeated on the same ant-hill: the day was gloomy, with steady light rain, and the temperature of the air at eleven o'clock A.M. was only 54°. The temperature of the ant-hill varied but little in its different parts, but it was greatest near the surface. At the depth of one inch it was 65°; at two inches 66°, below which it gradually diminished. In another nest, twice the size of the first, the temperature of the air being 54°, that of the nest, when the insects were a little excited, was 74°.

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* Kirby and Spence.

These results greatly resemble those obtained from the observations on bees, and tend to confirm the fact established by Mr. Newport that insects have a temperature higher than the surrounding air, which temperature increases as they pass from a tranquil to an excited state; or, in other words, their natural heat increases with the amount of respiration. Let us now return to the history of the brood.

In the course of a few days, the young grubs appear, and then the working ants have to labour almost without ceasing to supply their wants. Every evening before sunset they remove the whole brood, as well as the eggs and pupæ, to lower cells, where they will be safe from the cold; and in the morning they regularly bring them to the upper cells, unless there is a prospect of rain, and then they are allowed to remain in the lower chambers. The ants constantly regulate their proceedings by the sun, removing the brood according to his earlier or later rising and setting. As soon as the sun begins to shine on the nest, the ants that are keeping watch on the outside hasten below to rouse their companions, and soon the passages are seen to swarm with busy labourers, bringing up the larvæ and pupæ to bask in the rays for about fifteen minutes; after which they remove them to the upper apartments, where they are sheltered from too great a heat.

The feeding of the young brood is even a more serious charge than removing them to different parts of the nest. The nest is constantly stored with larvæ all the year round, and they require to be fed several times a-day, except in winter, when the whole colony is torpid. The larvæ, although apparently quite helpless, are voracious little creatures, eager to receive their food, lengthening their bodies, and with their mouths sucking the mouths of their nurses, just as little birds stretch out their necks and open their bills on the approach of their parents. The worker disgorges into its mouth a viscid, half-digested fluid, with which he supplies his little charge; but, it is probable, from the observations of Huber, that they require at one period a more substantial food than at another. The youngest brood at first wants but little nutriment, but requires constant attention; while the older brood needs incessant supplies. These broods, in a well-stocked nest, amount to seven or eight thousand nurslings, and the task of satisfying all their cravings, as well as providing for their own subsistence, falls to the lot of the working ants, whose duties would seem too great to be borne by such minute agents; yet they are patiently gone through, by dint of the incessant activity with which we see them foraging on every side.

Nor does their labour end here. It is necessary that the larvæ should be kept extremely clean; and for this purpose the ants are perpetually passing their tongue and mandibles over their body, rendering them by this means perfectly white. After the young grubs have attained their full growth, they leave off eating, surround themselves with a silken cocoon, and become *pupæ*, which, food excepted, require as much attention as in the larvæ state. Every morning they are transported from the bottom of the nest to the surface, and every evening returned to their former quarters. And if, as is often the case, the nest be thrown into ruins by the unlucky foot of a passing animal, in addition to all these daily and hourly avocations is superadded the immediate necessity of collecting the pupæ from the earth with which they have been mixed, and of restoring the nest to its pristine state.*

"Nothing can be more curious than the view of the interior of a fully-peopled ants' nest in summer. In one part are stored the eggs; in another, the pupæ are heaped up by hundreds in spacious apartments; and in a third, we see the larvæ surrounded by the workers; some of which feed them, while others keep guard, standing erect upon their hind legs, in the position for darting their acid; than which gunpowder would not be more formidable to most of their foes. Some, again, are occupied in clearing the alleys from obstructions of various kinds; and others rest in perfect repose, recruiting their strength for new labours."

When the young ants are ready to come out of their silken shroud, the workers, who, by some wonderful instinct, seem to know the exact time, bustle about; three or four mount upon one cocoon, and with their mandibles begin to open it in the part where the head lies. They first pull off a few threads to render the place thinner; they then make several small openings, and cut the threads which separate them one by one, till the opening is large enough to let out the prisoner; all which is done with great gentleness. The ant is still wrapped up in a pellicle, which the workers also pull off, carefully disengaging every member from its case, and nicely expanding the wings of such as are furnished with them. The workers still attend the new-born insects for some days, watching over them, feeding them, and teaching them the various turnings and windings of the nest.

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* Bird-fanciers avail themselves of the attachment of ants to their young for obtaining a collection of the pupæ, which they sell as a dainty food for nightingales, larks, &c. They scatter an ants' nest upon a dry plot of ground, surrounded with a shallow trench of water, and place on one side of it a few fir-branches. The ants, anxious to shelter and conceal their pupæ, arrange them under the branches, and in an hour or two the bird-fancier finds a large heap, clean and ready for the market.

"Thus, from the very moment of the extrusion of the egg to the maturity of the perfect insect, are the ants unremittingly occupied in the care of the young of the society, and that with an ardour of affectionate attachment, to which, when its intensity and duration are taken into the account, we may fairly say, there is nothing parallel in the whole animal world. Amongst birds and quadrupeds we have instances of affection as strong, perhaps, while it lasts; but how much shorter the period during which it is exerted! In a month or two, the young of the former require no further attention; and if, in a state of nature, some of the latter give suck to their offspring for a longer period, it is on their parts without effort or labour; and in both cases, the time given up to their young forms a very small part of the life of the animal. But the little insects in question not only spend a greater portion of time in the education of their progeny, but devote even the whole of their existence, from their birth to their death, to this one occupation!"*

It has been stated, that at the first formation of a nest the female performs all the maternal duties, which are afterwards attended to by the workers. It is only when the workers are sufficiently numerous that she resigns this charge to them, after which she has enough to do to furnish eggs for the future supply of females, males, and workers, which, according to Gould, are laid at three different seasons.

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* Kirby and Spence.

There is one circumstance connected with these winged females which must excite surprise and admiration. When the beautiful wings have served the purpose of conveying a female away from her home, and she is settled down in a spot in which a new colony is to be founded, the first thing she does is, to strip off her wings, which are now no longer of any use. Huber's observations on this subject, which have been abundantly confirmed by naturalists, are very interesting. He says, "One day, wishing to ascertain the precise condition of the females, I visited certain ant-hills which I knew to be filled with winged ants, and whose departure could not be very distant. Scarcely had I reached the spot, when I saw several, both females and males, pass over my head. While at the ant-hill, I observed several take flight, the males always preceding, and the labourers, as far as they could, accompanying them. I took eight pairs of these, and placed them in a box, to observe them on my return; but a violent rain, which came on at this moment, offered me a sight as singular as unexpected. As soon as the shower had passed, I saw the earth strewed with females without wings; they were, most likely, the very same females I had seen in the air; they were of the same species *(F. brunnea)* as the first.

"On my return home, I placed my eight prisoners, with some moistened earth, in a garden vase, covered with a glass receiver. It was nine o'clock in the evening; at ten the females had lost their wings, which I observed scattered here and there, and were hiding themselves under the earth. On the following day I procured three other females, and this time I observed them with the greatest attention from the moment of pairing until nine in the evening—a period of five hours; but during this time nothing was done to denote the approaching loss of their wings, which remained still firmly affixed. They appeared to be in excellent condition; and when I saw them pass their feet across their mouths, then over the antennæ, and again brush them upon one another, I expected to see their wings fall off, and could not conceive what delayed this, since the others had lost them so readily. I had no idea that the mere difference of the bottom of a sand-box, where there was no earth, would have had any influence in preventing this; but, in order that it might not affect them, I took some earth, strewed it lightly over the table, and covered it with a bell-glass. I still possessed three winged females, one of which I introduced under the glass. I induced her to go there freely, by presenting her a fragment of straw, on which I conveyed her to her new habitation, without touching her. Scarcely did she perceive the earth which covered the bottom of her abode, than she extended her wings with some effort, bringing them before her head, crossing them in every direction, throwing them from side to side, and producing so many singular contortions, that all her four wings fell off at the same moment in my presence. After this change she reposed, brushed her corslet with her feet, then traversed the ground, evidently appearing to seek a place of shelter. She did not seem to be in the least aware that she was confined within a narrow inclosure; she partook of the honey I gave her, and at last found a hiding-place under some loose earth, that formed a little natural grotto.

"If I was surprised at seeing this female strip herself of her wings voluntarily, I was even more so on finding that she did not appear to suffer from it, and that, after an act which would seem to us anything but natural, she began quietly to eat, and then sought a retreat, as if nothing remarkable had happened. This singular fact required confirmation. I introduced a second female under the bell-glass about two hours afterwards, and with the same precautions, adding to the dry earth a little water. When she perceived that she stood upon moistened earth, she advanced a few paces, felt the ground with her antennæ, and took up a position, in order to dispossess herself of her wings. Resting on her belly, she opened her wings in a disorderly manner, extended them in every direction, passed her legs, behind them, and pressed them closely toward the ground. When she had succeeded in getting rid of them, I observed her walk about tranquilly in her enclosure, and begin constructing a grotto of earth.

"I still possessed another, which I reserved for the following morning; and, being confined to the dry sand, she had not lost her wings, though it was about sixteen hours later than the two former ones. She appeared in excellent condition, and had not apparently suffered by the delay. Scarcely had she touched the ground, than she hastened to get rid of her wings in the same manner as the others had done. Finally, I repeated the like experiments on several females of different species, and always obtained the same result."

Gould, a much earlier writer than Huber, in his account of English ants, notices the fact, that the large *ant-flies,* as he calls them, "just before or after leaving the colonies, actually drop their wings;" and he remarks that, "the casting of their wings is an instance peculiar to the large ant-flies. These are, to other insects, their highest decorations, and the want of them lessens their beauty, and shortens their life. On the reverse, a large ant-fly gains by the loss, and is afterwards promoted to a throne, and drops these external ornaments as emblems of too much levity for a sovereign."

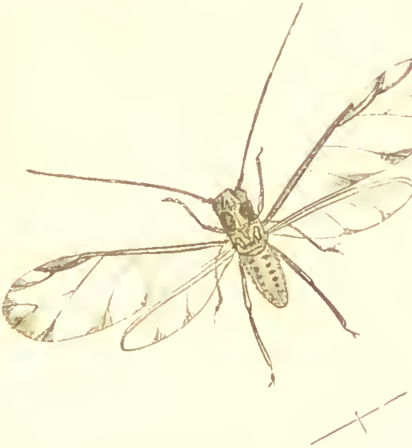
The respect paid by the workers to their queen is very remarkable. As soon as a female is acknowledged as a parent, the workers begin to pay her homage; they press round her, offer her food, conduct her by her mandibles through the winding galleries, and carry her over the steep or difficult passages, while she coils herself round so as to incommode her bearers as little as possible. Huber says, that even if she dies, they sometimes continue for months the same attentions to her; they brush her, lick her, and treat her with the same formality as if she were alive. Gould also bears testimony to the respect paid to the queen. "In whatever apartment a queen condescends to be present, she commands obedience and respect; a universal gladness spreads itself through the whole cell, which is expressed by particular acts of joy and exultation; they have a peculiar way of skipping, leaping, standing on their hind legs, and prancing with the others. These frolics they make use of, both to congratulate each other when they meet, and show their regard for the queen. Some of them gently walk over her, some of them dance round her: she is generally encircled by a cluster of attendants, who, if you separate them from her, soon collect themselves into a body, and enclose her in the midst."

No one can witness the operations of ants without being convinced that they have a ready and effectual means of communicating with each other, of explaining their wants to each other, and of imparting information. They appear to do this by means of their antennæ, touching each other with them in various ways, so as to form a complete set of signals, intelligible to all the members of the species. Huber calls this *antennal language.* By means of the antennæ they inform their companions of danger; of the time of departure, and of the route to be taken, in their excursions; of the presence of the rising sun upon their house-top, and numerous other circumstances. When one ant is hungry, it strikes both its antennæ, with a rapid motion, against the antennæ of the ant who has been out for a supply; it then approaches closer, with open mouth, and tongue extended, to receive the juice which the first ant has prepared from the ripe fruits, worms, insects, &c. met with in foraging. While the ant is receiving food, it does not cease for a moment to caress its kind friend, by continuing to move its antennæ with great quickness; it also smoothes down, with its brush-like paws, the back of the head of its benefactor, with a movement as delicate and rapid as that produced by the antennæ.

This faculty of the ants being able to convey precise information to each other has been illustrated by a variety of anecdotes, one of which is related by Dr. Franklin. He put a little earthern pot, containing some treacle, into a closet, into which a number of ants collected, and devoured the treacle very quickly. On observing this the doctor shook them out, and tied the pot with a thin string to a nail fastened into the ceiling, so that it hung down by the string. A single ant by chance remained in the pot. This ant ate till it was satisfied; but when it wanted to get off it could not for some time find a way out; it ran about the bottom of the pot, but in vain. At last it found, after many attempts, the way to the ceiling by going along the string. After it was come there, it ran to the wall, and from thence to the ground. It had scarcely been away half an hour, when a great swarm of ants came out, got up to the ceiling, and crept along the string into the pot, and began to eat again. This they continued till the treacle was all eaten; in the mean time one swarm was running down the string, and the other up.

The inference drawn from this anecdote was, that the solitary ant left in the pot of treacle went and informed its companions of the treasure, and how to get at it. They may, however, have discovered it by the smell, which is a very acute sense in ants. Mr. Rennie placed a bruised raisin, dipped in moist sugar, upon a grass-plot, where a few ants were observed straggling about; and it was not long before one of them discovered the prize. "Our object, however, being to prevent this individual from informing the rest, we seized it, as we did several others, as they successively arrived; but, although we were not aware of any ant-hill within a good many yards of the spot, we speak within compass when we say that we could have caught several hundreds within an hour at the raisin, none of which could by possibility have been informed by their companions, whom we kept close prisoners. That they were led to it by smell also appeared from those of the same nest arriving usually by the same straight track. We admit, indeed, that when we allowed the prisoners their liberty, a much greater number came to the feast; but that, as we imagine, was occasioned, as in Franklin's experiment, not by mutual communication, but by the scent of the sugar left in their path."

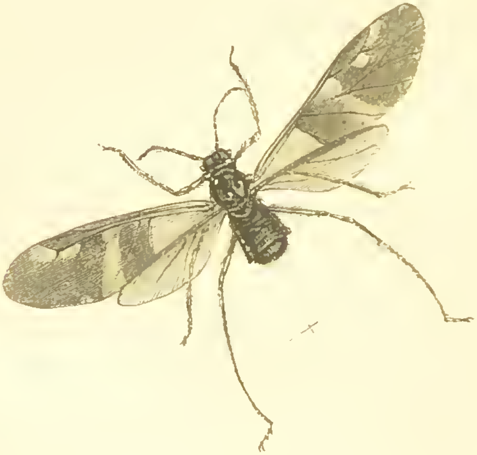
Ants do not seem to be very particular in their food; they devour most animal and vegetable substances, and seem destined to rank among the numerous scavengers of nature. They are, however, exceedingly fond of sweets, such as ripe fruit, honey, sugar, &c. and eagerly devour the honey-dew which is dropped by various species of aphides upon the leaves of trees. The aphis, plant-louse, or puceron, is a very destructive little insect, living entirely on vegetables, attacking the loftiest trees as well as the most humble plant. These insects suck the juices from young and tender shoots, but for the most part beset the foliage, and are always found on the under side of the leaf, where they find their favourite food, and are protected from the weather and various other injuries to which they would otherwise be exposed. They are exceedingly numerous, and each plant seems to have its own peculiar species. The following are enlarged representations of the aphides which beset the oak and the lime. From the body of most species project a pair of tubes, through which they eject the sweet



THE LIME-TREE APHIS.

(The lines under the Figure show the actual size of the insect.)

viscid fluid called *honey-dew.* This substance is often found in considerable quantities upon the upper surface of leaves, and proceeds from the aphides settled on other over-hanging leaves. Now it will probably excite the astonishment, if not the distrust, of the reader, to be informed that the ants actually take possession of these aphides, and retain them as the property of the colony, for the purpose of furnishing a supply of honey-dew. Linnæus remarks that the ant ascends trees, that it may milk its *cows*, the aphides ; and Kirby and Spence call the aphides the *milch-cattle* of the ants. Nay, more ; the ants often enclose the aphides on certain plants, within a cell of earth, which we may, perhaps, call their cow-house ; and they will not allow the ants of a neighbouring colony to visit this tree.



THE CLOUDED-WINGED OAK-LOUSE.
(The lines under the Figure show the actual size of the insect.)

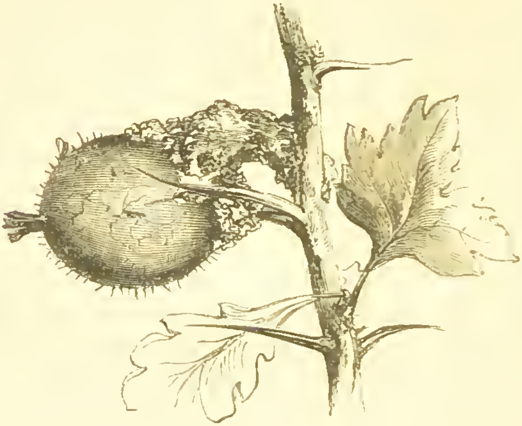
Four or five species of ants even keep a flock of aphides within their nest, and regularly every day take home green fodder for them; and even guard their eggs with as much care as their own larvæ. Mr. Kirby states that he has himself witnessed the care bestowed by ants on the eggs of the aphides, which they carry in their mouths, to give them the influence of sun and air, and afterwards carry them back to the interior of the nest. The object is evidently to hasten the development of the aphides.

The ants and the aphides seem to be on very good terms with each other. Huber has described the process of *milking* with his usual fidelity. "By watching a single brown ant in a branch of a thistle, I saw it at first pass, without stopping, some aphides, which it did not disturb, but shortly after stationed itself near one of the smallest, and appeared to caress it by touching its tail alternately with its antennæ, with an extremely rapid movement like the play of the fingers in a shake upon the pianoforte. I saw, with much surprise, the honey-dew escape from the body of the aphis, and the ant take it into its mouth. Its antennæ were directed to a much larger aphis than the first, which, on being caressed after the same manner, discharged the nourishing fluid in greater quantity, and this the ant immediately swallowed. In the same manner it proceeded to a third, a fourth, and a fifth; after which it returned to the nest. Those which remained on the thistle presented me with the same scene."

A correspondent in Loudon's Magazine of Natural

History relates the following anecdote, accompanied by an illustrative sketch :—

A gooseberry-tree was infested with aphides, on which a number of black ants were seen actively employed upon the leaves and fruit. On a closer examination they were discovered to be constructing mud roofs, or archways, from the stem of the plant to some of the fruit, leaving a part of the same uncovered. Within this dome or archway, a small flock of aphides was retained by the ants. Thus sheltered from the rain they nourished themselves, and afforded their sagacious shepherds their favourite honey-dew. Over some of these archways they had carefully glued a leaf of the tree, so disposed that the rain might easily glide off, and thus the mud roof was rendered impervious to the wet. The fruits thus erected upon had been chosen or first ascertained to be firmly fixed between two of the



spines, as in the sketch, or confined by the leaves and branches of the tree.

Even more extraordinary than the details just related, are the expeditions of certain species of ants to capture slaves to perform the work of the colony. There is something so strange in Huber's narrative of these slave-making expeditions, that one would be tempted to suppose that he laboured under a mistake, or allowed his imagination to get the better of his judgment, were it not that his facts have been abundantly verified by such respectable and trustworthy authorities as Jurine, Latreille, and Kirby.

It should be premised that the following account refers to two species of ants common on the Continent, but not found in Britain: they are called *legionary ants;* one is the rufescent ant (*F. rufescens*), and the other the sanguineous ant (*F. sanguinea*). The enslaved ants are of two species, a black ant (*F. fusca*), and a mining ant (*F. cunicularia*).

"On the 17th June, 1804," says Huber, "whilst walking in the environs of Geneva, between four and five in the evening, I observed a column of legionary ants crossing the road. They moved with considerable rapidity, and occupied a space of from eight to ten inches in length, by three or four in breadth. I followed them into a meadow, and observed them winding along the grass without straggling. They soon approached a nest inhabited by a colony of the negro ant (*F. fusca*), the dome of which rose above the grass at a distance of twenty feet from a hedge. Some of the negroes were guarding the entrance ; but on the discovery of an approaching army, darted forth upon the advancing legion. The alarm instantly spread into the interior, whence their companions rushed forth in multitudes to defend their common home. The legionaries, the bulk of whose army lay only at the distance of two paces, quickened their march, and when they arrived at the hill, the whole battalion fell furiously upon the negroes, who, after an obstinate though brief conflict, fled to their subterranean galleries. The legionaries now ascended the dome, collected in crowds on the summit, and taking possession of the principal avenues, left some of their companions to excavate other openings in the exterior walls. They soon effected this, and through the breach the remainder of the army made their entrance, but in about three or four minutes afterwards issued forth again, each carrying off a pupa or grub, with which booty they retraced their route in a straggling, irregular march, very different from the close, orderly array they had before exhibited."

On returning to examine the state of the plundered nest, M. Huber found a small number of the negro workers perched on the stalks of plants, holding in their mouth the few grubs they had succeeded in preserving from the pillage. On the next day M. Huber witnessed a similar expedition of the legionaries, and this time followed them to their nest with their booty; but what was his surprise to observe all around a great number of the very same negro species which they had gone forth to attack!

"I raised up a portion of the building, and upon still perceiving more, I imagined that it was one of the encampments which had already been pillaged by the legionaries, but I was set right by the arrival, at the entrance, of the very army I had been watching, laden with the fruits of their victory. Its return excited no alarm among the negro-ants, who, so far from offering opposition to the entrance of the victorious army, even approached the warriors to caress them, and present them with food as is the custom among their own species, whilst the legionaries, in their turn, consigned to them their prisoners to be carried into the interior of the nest."

In attacking the communities of the mining-ants, the legionaries have a more difficult task than in the case of the negroes, as will appear from the following account :—" Between four and five in the evening, a time when the army usually commences its march, the legionaries were already assembled on the nest, and ready to set forth. They proceeded like a torrent along a deep hollow, and marched in a more compact body than ordinary, till they arrived at a nest of miners which they intended to attack. As soon as the invading army began to enter the subterranean city the miners rushed out in crowds, and while some fell upon the invaders with great spirit, others passed through the scene of contest, solely occupied in bearing off the larvæ and pupæ to a place of safety. The surface of the nest was for some time the theatre of war. The miners often recovered from the legionaries the pupæ they had captured, darting upon them with fury, and fighting with desperation. The legionary army, however, gained the victory, and recommenced its march, in good order, laden with booty; but instead of proceeding in file, it now maintained close rank, forming a compact mass—a precaution the more necessary, as the courageous miners hastened in pursuit, and continued to harass their march to within ten paces of their citadel.

"During these combats the pillaged ant-hill presented in miniature the spectacle of a besieged city; hundreds of the inhabitants being seen to quit it, carrying off their young to preserve them from the enemy. The greater number mounted the neighbouring plants, bearing the young in their mandibles, and others hid them under thick bushes. When the danger appeared to be over, they brought them back to the city and barricaded the gates, near which they posted themselves in great force, to guard the entrance."

It is a remarkable example of insect prudence, that the invaders, in these expeditions, never capture the old negroes, being probably aware of the impossibility of taming them down to the condition of slaves. Their object is to obtain a number of pupæ, in which the young ants being in a state of repose, have as yet formed no attachment to the place of their nativity. On the contrary, they look upon the enemy's encampment as their home, and employ their natural activity in repairing and enlarging it, as well as adding to its stores of provisions. And not only do they live socially with their captors, but bestow the greatest care upon their larvæ and pupæ, their males and females, transporting them from one part of the colony to another, feeding them, forming new galleries as occasion requires, acting as sentinels, by guarding the exterior of their common abode, apparently not once suspecting that they live with those very insects which kidnapped them in their helpless and unconscious infancy. Whilst the negro-ants are engaged in these laborious employments, their masters rest tranquilly at the bottom of their subterranean city, till the hour fixed for their expeditions arrives ; reserving their strength, courage, and skill, for the purpose of bringing in from some adjacent colony hundreds of pupæ, which they confide to the charge of their slaves.

It is justly remarked by Latreille, who has verified all the statements of Huber, that the ants carried off by the warriors are not rendered miserable, as in the case of human slaves, for their condition remains unaltered. They live unconstrained, destined by nature to perform the same services. They find in the home of the stranger the same objects which would have attached them to their own, and even the young of their own species, which they nurse and bring up together with those of their masters. As to the warriors themselves, in these slaving expeditions, they are but following the instincts of their nature. The colonies of most ants consist of males, females, and neuters or workers ; but in the case of the legionary ants the workers have to be sought for elsewhere, and indeed without them the race would soon become extinct, because it is physically impossible for the rufescent ants, on account of the form of their jaws and other parts of the mouth, either to prepare habitations for their families, to procure food, or even to feed themselves. Nature has furnished them with fighting weapons only, and their only occupation is war. Their societies are but limited, while those of the negro and mining ants are exceedingly numerous, and the one checks the too rapid increase of the other.

The slaves seem to be perfectly aware that their masters are dependent upon them for food, and lodging, and every comfort; and, on some occasions, seem rather to command than obey. They will not allow the warriors to leave the colony alone, nor before the proper season; and when the warriors return from an excursion without a captive, they meet with a very cold reception, and are often refused admission.

Huber has shown by a striking experiment how absolutely dependent are the warriors upon their slaves. He enclosed thirty of the legionary ants with several pupæ and larvæ of their own species, and twenty pupæ belonging to the negroes in a glazed box, the bottom of which was covered with a thick layer of earth. A little honey was put in one corner, and all the slaves excluded. At first they appeared to pay some little attention to the larvæ; they carried them about, but soon replaced them. Strange as it may appear, they made no attempt to feed themselves, and more than half of them died of hunger in less than two days. They had not even traced out a dwelling, and the few individuals still alive were languid and without strength. At length, pitying their condition, Huber admitted a single negro ; and this active little servant, alone and unassisted, established order, formed a chamber in the earth, collected the larvæ, and placed them in it, assisted the pupæ that were ready to be developed, and preserved the lives of the remaining legionaries.

Quitting these astonishing details, we proceed to notice the behaviour of ants towards each other. Among those inhabiting the same colony, there is much of what appears to be kindness and goodwill. "Whether ants, with man and some of the larger animals, experience anything like attachment to individuals, is not easily ascertained ; but that they feel the full force of the sentiment which we term patriotism, or the love of the community to which they belong, is evident from the whole series of their proceedings, which all tend to promote the general good. Distress or difficulty falling upon any member of their society generally excites their sympathy, and they do their utmost to relieve it. Latreille once cut off the antennæ of an ant ; and its companions, evidently pitying its sufferings, anointed the wounded part with a drop of transparent fluid from their mouths. Whoever attends to what is going forward in the neighbourhood of one of their nests will be gratified to observe the readiness with which they seem disposed to assist each other in difficulties. When a burden is too heavy for one, another will soon come to ease it of part of the weight; and if one is threatened with an attack, all hasten to the spot to join in repelling it. The satisfaction they express at meeting after absence is very striking, and gives some degree of individuality to their attachment. Huber witnessed the gesticulations of some ants, originally belonging to the same nest, that, having been entirely separated from each other four months, were afterwards brought together. Though this was equal to one-fourth of their existence as perfect insects, they immediately recognised each other, saluted mutually with their antennæ, and united once more to form one family."

The working ants have been thus far described as incessantly labouring for the community. It is pleasing to find that they also have their sports, and pastimes, and enjoyments. On a fine sunny day they may often be seen outside their hills basking in the sun, at other times indulging in a regular game of romps. "You may frequently perceive," says Gould, "an ant run to and fro with a fellow-labourer in his forceps, of the same species and colony. It appeared first in the light of provisions: but I was soon undeceived by observing, that after being carried for some time, it was let go in a friendly manner, and received no personal injury. This amusement, or whatever title you please to give it, is often repeated, particularly amongst the hill-ants, which are very fond of this sportive exercise."

But the most circumstantial account of the sports of ants has been given by Huber. He says—

" One day I approached a formicary of wood-ants which was exposed to the sun, and sheltered from the north. The ants were heaped upon one another in great numbers, and appeared to enjoy the warmth of the surface of the nest. None of them were at work ; and the immense multitude of insects presented the appearance of a boiling liquid, upon which the eye could scarcely be fixed without difficulty ; but, when I examined the conduct of each ant, I saw them approach one another, moving their antennæ with astonishing rapidity, while they patted with a slight movement the cheeks of other ants. After this they were observed to raise themselves upright on their hind legs by pairs, struggle together, seize each other by a mandible, foot, or antenna, and then immediately relax their hold to recommence the attack. They fastened upon each other, embraced and overthrew each other, then raised themselves by turns, taking their revenge without doing any serious mischief. They presently abandoned those which they had first seized, and endeavoured to catch others. I have seen some who were so eager in these exercises, that they pursued several workers in succession, and struggled with them a few moments, the skirmish only terminating when the least animated, having overthrown his antagonist, succeeded in escaping, and hiding in one of the galleries. In one place two ants appeared to be gambolling about a stalk of grass, turning alternately to avoid or seize each other, which brought to my recollection the sport and pastime of young dogs when they rise on their hind legs attempting to bite, overthrow and seize each other, without once closing their teeth. To witness these facts, it is necessary to approach the ant-hills with much caution, that the ants should have no idea of our presence; if they had, they would instantly give up their games and occupations, and put themselves in a posture of defence."

But if the ants of the same colony are thus friendly towards each other, those of neighbouring colonies do not always live so peaceably. Causes of dissension may arise to light the flame of war between them. "To these little bustling creatures a square foot of earth is a territory worth contending for; their droves of aphides are equally valuable with the flocks and herds that cover our plains; and the body of a fly or a beetle, or a cargo of straws and bits of stick, an acquisition as important as the treasures of a Lima fleet to our seamen." The battles of the ants are usually between nests of different species, but sometimes they occur between those of the same species.

"If," says Huber, "we wish to behold regular armies wage war in all its forms, we must visit the forest in which the wood-ant establishes its dominion over every other insect within the neighbourhood of the colony. We shall there see populous and rival cities and regular military roads, diverging from the ant-hill like so many rays from a centre, frequented by an immense number of combatants of the same species, for they are naturally enemies, and jealous of any encroachment upon the territory which surrounds their capitals. I have witnessed in these forests the inhabitants of two large ant-hills engaged in spirited combat; two empires could not have brought into the field a more numerous or more determined body of combatants. The rival cities were situated about a hundred paces from each other, and alike in extent of population; what occasioned their discord I cannot pretend to say.

" Let us figure to ourselves this prodigious crowd of insects covering the ground lying between these two ant-hills, and occupying a space of two feet in breadth. Both armies met at half way from their respective habitations, and there the battle commenced. Thousands of ants took their station upon the highest ground, and fought in pairs, keeping firm hold of their antagonists by their mandibles; a considerable number were engaged in the attack and leading away prisoners. The latter made several ineffectual efforts to escape, as if aware that upon their arrival at the camp, they would experience a cruel death. The scene of warfare occupied a space of about three feet square; a penetrating odour exhaled from all sides; numbers of dead ants were seen covered with venom. The ants, composing groups and chains, laid hold of each other's legs and pincers, and dragged their antagonists on the ground. These groups formed successively. The fight usually commenced between two ants, who seized each other by the mandibles, and raised themselves upon their hind legs, to allow of their bringing their abdomen forward, and spurting the venom upon their adversary. They were often so closely wedged together that they fell upon their sides, and fought a long time in that situation in the dust, till a third came to decide the contest. It more commonly happened that both ants received assistance at the same time, when the whole four, keeping firm hold of a foot or antenna, made ineffectual attempts to win the battle. In this way they sometimes formed groups of six, eight, or ten, firmly locked together, the group being only broken when several warriors from the same republic advanced at the same time and compelled the enchained insects to let go their hold, and then the single combats were renewed. On the approach of night, each party retired gradually to their own city.

"Next morning, before dawn, the combatants returned to the field of battle, the groups again formed, the carnage recommenced with greater fury than on the preceding evening, and the scene of combat occupied a space of six feet in length by two in breadth. The event remained for a long time doubtful; but about mid-day the contending armies had removed to the distance of a dozen feet from one of the cities, whence, I conclude, some ground had been gained. The ants fought so desperately that they did not even perceive my presence; for though I remained close to the combatants, not one of them attempted to climb my legs, seeming to be wholly absorbed in the object of finding an enemy to wrestle with. During this furious warfare the common operations of the two colonies were not suspended, for the paths which led to a distance in the forest, were as much thronged as in time of peace, and all around the ant-hill order and tranquillity prevailed. On that side alone where the battle raged were seen crowds of the colonists running to and fro, some to join the army, and some to escort the prisoners. This war terminated without any disastrous results to the two republics. In fact it appeared that its duration was shortened by long-continued rains, which compelled each of the belligerents to keep within their walls, and the warriors ceased to frequent the road which led to the camp of the enemy."

The battles of the ants, though not the most pleasing part of their history, nevertheless display their good citizenship, and afford proof of that prudent and wise policy which holds them together as one community, and teaches them to resist the aggressions of encroaching neighbours. While thus bold and warlike among themselves, they are harmless or rather positively beneficial to mankind. They are not injurious to the products of the farm or of the garden ; they do some injury to lawns and pastures, in which their nests are often constructed, and cattle seem to have a great dread of browsing near them. But their office in nature seems to be to clear off dead and decaying substances, which might otherwise prove offensive, and this is of immense importance to health, especially in warm climates. In some parts of the world they are the declared enemies of vermin of every kind, and will enter a house in immense numbers, apparently for the sole purpose of clearing it of cockroaches, mice, rats, and similar animals. Mrs. Carmichael has described a visit which she received from the *Chasseur ants* of Trinidad, while seated one morning with her family at breakfast.

"The open rafters of a West India House," she says, "at all times afford shelter to a numerous tribe of insects, more particularly the cockroach; but now their destruction was inevitable. The Chasseur ants, as if trained for battle, ascended in regular thick files to the rafters, and threw down the cockroaches to their comrades on the floor, who as regularly marched off with the dead bodies of cockroaches, dragging them away by their united efforts with amazing rapidity." When the ants had cleared off the insects, "they commenced an attack upon the rats and mice, which, strange as it may appear, were no match for their apparently insignificant foes. They surrounded them as they had the insect tribe, covered them over and dragged them off with a celerity and union of strength that no one who has not watched such a scene can comprehend. I did not see one rat or mouse escape. and I am sure I saw a score carried off during a a very short period. * * I think it was about ten when I first observed the ants; about twelve the battle was formidable; soon after one o'clock, the great strife began with the rats and mice; and about three, the houses were cleared. In a quarter of an hour more the ants began to decamp. and soon not one was to be seen within doors." The inhabitants regard such a visitation of the Chasseur ants as a great blessing, and throw open all their doors, cupboards, boxes, &c. to admit them, and they certainly do their work thoroughly, not a single insect remaining in the house after their departure.

THE ANT-HILL.

HILL NESTS OF THE WHITE ANTS.

THE ANT,

AS AN EXAMPLE OF PRUDENCE.

Part II.—TERMITES, OR WHITE ANTS.

There remains to be noticed a family of insects whose labours and economy are perhaps even more wonderful than the preceding. We allude to the Termites, or *White Ants,* as they are popularly called, although they belong to a different family from the true ants. They belong to the order *Neuroptera;* that is, they have four wings, in which the nervures or veins are boldly marked, giving to them, when seen under the microscope, the appearance of a beautiful net-work. They resemble the true ants *(Formicidæ)* in living in communities, constructing hills or turrets for their nest, carefully nursing their young, and being

composed of males, females, and neuters. These latter act as the soldiers, or guardians of the colony; and in addition to them there are workers and nymphs; the workers being considered as the larvæ, and the nymphs the pupæ of the perfect insect.

SOLDIER.

WORKER.

In a society of termites the workers are most numerous and active; they erect and keep in repair the buildings, collect provisions, attend the female, convey the eggs to the nurseries, and feed the young larvæ till they are old enough to take care of themselves. They are distinguished from the soldiers by their diminutive size, by their round heads and shorter mandibles.

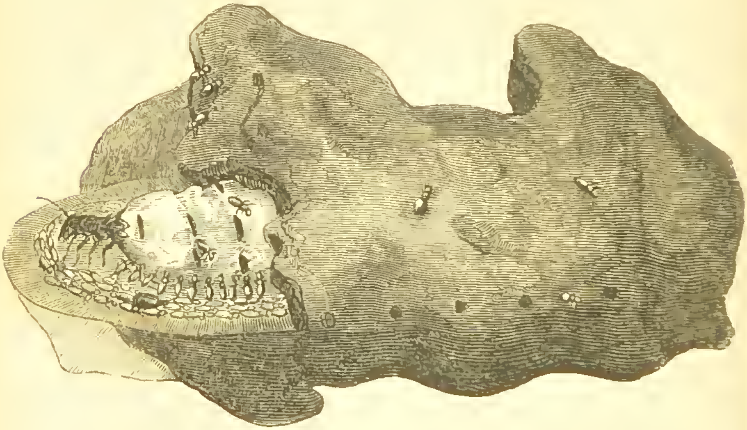
The nymphs or pupæ resemble the larvæ, except that they have wings folded up in cases.

The neuters are less numerous than the workers, bearing the proportion of one to one hundred, and exceeding them greatly in bulk. They are distinguished by their long and large head, armed with very long mandibles. They act as sentinels in time of peace, and as soldiers when the nest is attacked.

There is only one male and one female in every separate society: they may be distinguished by their large and prominent eyes; at first they have four wings, but they soon cast them.

The termites are found in both the Indies, in Africa, and in South America. The first establishment of one of their colonies takes place as follows. In the evening, soon after the first tornado, which at the latter end of the dry season, proclaims the approach of the ensuing rains, these animals, having attained their perfect state, in which they have two pair of wings, emerge from their clay-built citadels by myriads to seek their fortune. They fill the air, enter houses, extinguish lights, and are even sometimes driven on board ships that are not far from the shore. Next morning they are seen covering the surface of the earth and waters, deprived of the wings which are only calculated to carry them a few hours. From the most active and rapacious of insects they are now the most helpless and cowardly, becoming the prey of innumerable enemies, to the smallest of which they make no resistance. Ants are on the hunt for them; birds, reptiles, beasts, and even men, look upon this event as their harvest, and make them their food. "I have discoursed with several gentlemen," says Smeathman, "upon the taste of the white ants; and, on comparing notes, we have always agreed that they are most delicious and delicate eating. One gentleman compared them to sugared marrow, another to sugared cream, and a paste of sweet almonds."

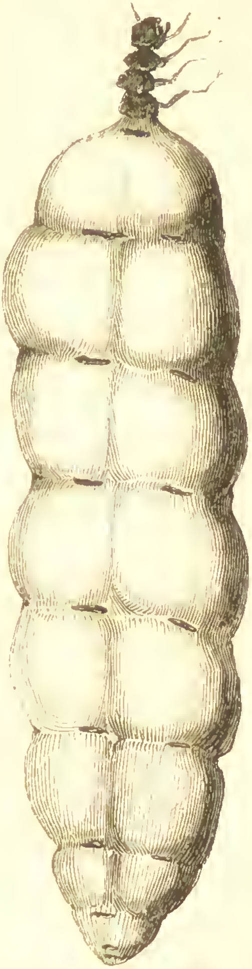
Surrounded by so many enemies, it is not surprising that scarcely a single pair out of many millions escape to a place of safety to lay the foundation of a new community. Those that do escape are usually found by workers, who are continually prowling about in their covered ways; they immediately pay them homage, elect them king and queen, or rather, the father and mother of a new colony. The workers immediately begin to protect them from their surrounding enemies, by enclosing them in a small chamber of clay, suited to their size, the entrances to which are only large enough to admit themselves and the neuters, but much too small for the royal pair to pass through, so that they can never leave it. The female now begins to furnish the infant colony with eggs, which, as they are laid, are taken by the industrious workers, and deposited in nurseries. The workers supply the royal pair with all they want, and as they increase in size they enlarge the royal cell. The number of eggs laid by the queen is astonishingly large. She has been known to lay sixty in a minute, or 80,000, and upwards, in twenty-four hours. As the females live two years in their perfect state, the number of eggs produced must be enormous.



QUEEN TERMES IN HER CELL.
(The front part broken open to show the interior.

The royal cell is always full of workers to take charge of the eggs. When hatched, they are fed, and properly attended to, till able to shift for themselves. The royal cell also contains soldiers—a sort of body-guard to the royal pair—while numerous workers and soldiers in waiting occupy the surrounding apartments, to attend to the wants, or to defend the persons of the royal pair.

The manner in which the termites feed the young brood is not well known. As soon as they are strong enough to share in the labours of the nest, they are set to work. They always work under cover, and even when they have a long journey to perform, such as over a rock or up a tree, they vault, with a coping of earth or clay, the route they mean to pursue. Were they to expose themselves, the race would soon be annihilated by their numerous enemies. Their diligence in building is very remarkable, as will appear from the following detailed account of their nests, abridged from Mr. Smeathman's paper on the subject, in the "Philosophical Transactions of the Royal Society of London."



QUEEN TERMES.
(*Removed from her cell.*)

KING TERMES.

The nests of the white ant are so numerous in the island of Bananas, and the adjacent continent of Africa, that it is scarcely possible to stand in any open place, such as a rice plantation, without seeing one or more of them within fifty paces. In some parts near Senegal, as mentioned by Adanson, their number, magnitude, and closeness of situation, make them appear like the villages of the natives. From the outward appearance of these nests they are usually termed *hills*. They are of conical form, and about ten or twelve feet in height. They are quite bare, until they are six or eight feet high; but in time they become almost covered with grass and other plants, and in the dry season, when the herbage is burnt up by the rays of the sun, they are not unlike very large hay-cocks.*

The exterior of the building consists of one large shell, strong enough to shelter the interior from the vicissitudes of the weather, and the inhabitants from the attacks of enemies. It is always, therefore, much stronger than the interior building, which is the habitable part, divided with wonderful regularity and contrivance into an amazing number of apartments for the residence of the king and queen, and the nursing of their numerous progeny; and also for magazines, which are always found well filled with stores and provisions.

These hills make their first appearance above ground by a little turret or two, in the shape of sugar-loaves, which are run a foot high, or more. Soon after, at some little distance, while the former are increasing in height and size, the ants raise others, and so go on increasing the number, and widening them at the base, till their works below are covered with these turrets, which they always raise the highest and largest in the middle, and by filling up the intervals between each turret, collect them as it were into one dome. They are not very exact about these turrets, except in making them very solid and strong; and when, by the junction of them, the dome is completed, for which purpose the turrets answer as scaffolds, they take away the middle ones entirely, except the tops, (which joined together make the crown of the cupola,) and apply the clay to the building of the works within, or to erecting fresh turrets, for the purpose of raising the hillock still higher, so that no doubt some part of the clay is used several times, like the boards and posts of a mason's scaffold.

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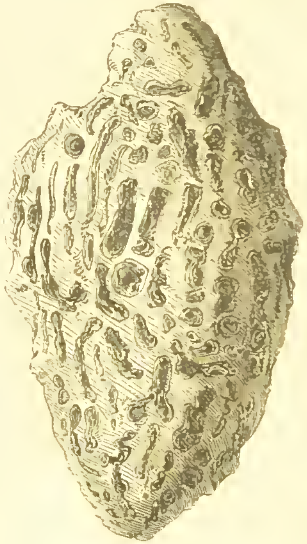
* See Frontispiece, at p. 208.

When these hills are at little more than half their height, the wild bulls are accustomed to stand as sentinels upon them, while the rest of the herd is ruminating below. They are quite strong enough for the purpose, and at their full height make excellent reconnoitring places. Mr. Smeathman says that he has been with four men on the top of one of these hillocks, when word was brought that a ship was in sight.

The outer shell or dome is not only of use to protect and support the interior buildings from external violence and heavy rains, but to collect and preserve a regular degree of genial warmth and moisture, which seems very necessary for hatching the eggs, and cherishing the young ones. The royal chamber appears to be, in the opinion of this little people, of the utmost consequence, being always situated as near the centre of the interior building as possible, and generally about the height of the common surface of the ground, at a pace or two from the hillock. It always resembles the shape of half an egg within, and may be supposed to represent a long oven. In the infant state of the colony it is not above an inch in length, but in time will be increased to six or eight inches, or even more, being always in proportion to the size of the queen, who, increasing in bulk as in age, at length requires a chamber of such dimensions.

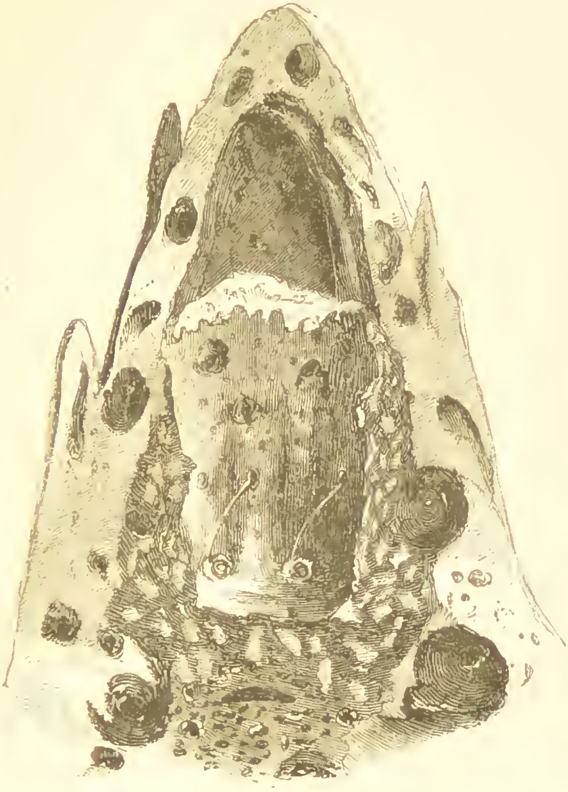
The floor of this part is perfectly horizontal, and in large hillocks, sometimes an inch thick and upwards, of solid clay. The roof, also, which is one solid and well-formed oval arch, is generally of about the same solidity, but in some places it is not a quarter of an inch thick: this is on the sides where it joins the floor, and where the doors or entrances are made level therewith, at pretty equal distances from each other. These entrances will not admit any animal larger than the soldiers or labourers, so that the king and queen can never possibly go out.

The royal chamber, if in a large hillock, is surrounded by a vast number of others of different sizes, shapes, and dimensions; but all of them are arched, the arches being sometimes circular and sometimes oval. These either open into each other, or communicate by passages equally wide, and being always empty, are evidently made for the soldiers and attendants, great numbers of whom are necessary, and are always in waiting. These apartments are joined by the magazines and nurseries. The former are chambers of clay, and are always well filled with provisions; which, under the microscope, appear to consist of the gums, or inspissated juices of plants. These are thrown together in little masses, some of which are finer than others, and resemble the sugar about preserved fruits; others are like tears of gum; one quite transparent, another like amber, a third brown, and a fourth quite opaque, as we often see in parcels of ordinary gums. These magazines are intermixed with the nurseries, and are totally different from the rest of the apartments; for these are composed entirely of wooden materials, seemingly joined together with gums. Mr. Smeathman calls them *nurseries*, because they are invariably occupied by the eggs and young ones; the latter appear at first in the shape of labourers, but white as snow. These nurseries are exceedingly compact, and divided into very small irregularly-shaped chambers, not one of which is to be found half an inch wide. They are placed all round the royal apartment, and as near as possible to it. When the nest is in the infant state, the nurseries are close to the royal chamber; but, as in process of time, the queen enlarges, it is necessary to enlarge this chamber also for her accommodation; and as she then lays a greater number of eggs, and requires a greater number of attendants, so it is necessary to enlarge and increase the number of the adjacent apartments; for which purpose the small nurseries that are first built are taken to pieces, rebuilt a little farther off, and a size larger, their number being at the same time increased. The nurseries are always found slightly overgrown with mould, and plentifully sprinkled with white globules, about the size of a small pin's-head. On examining them under a microscope, they appear to be a species of fungus, in shape like a mushroom. The nurseries are enclosed in chambers of clay like those which contain the provisions, but much larger. In the early state of the nest, they are not



CELLS OF TERMITES.

larger than a hazel-nut, but in old hills are often as large as a child's head.



SECTION OF THE HILL NEST OF THE TERMITES BELLICOSI.

After the enlargement of the royal chamber, it is surrounded on all sides, both above and below, by apartments for labourers and soldiers, who wait there, either to guard or serve their common father and mother; on whose safety depends the happiness, and probably even the existence, of the whole community. These apartments compose an intricate labyrinth, which extends a foot or more in diameter from the royal chamber on every side. Here the nurseries and magazines of provisions begin; and being separated by small empty chambers, and galleries which go round them, or communicate from one to the other, are continued on all sides to the outward shell, and attain two-thirds or three-fourths of its height, leaving an open area in the middle, under the dome, which very much resembles the nave of a cathedral: this is surrounded by three or four very large Gothic-shaped arches, which are sometimes two or three feet high next the front of the area, but diminish very rapidly as they recede from thence, like the arches of aisles in perspective, and are soon lost among the innumerable chambers and nurseries behind them. These chambers and the passages communicating with them, being arched, help to support each other; and while the interior large arches prevent their falling into the centre and keep the area open, the exterior building supports them on the outside. There are comparatively few openings into the great area; and they, for the most part, seem intended only to admit into the nurseries that genial warmth which the dome collects. The interior building, or assemblage of nurseries, chambers, &c., has a flattish top, or roof, without any perforation, which would keep the apartments below dry, in case, through accident, the dome should receive any injury and let in water. And it is never exactly flat and uniform, because the labourers are always adding to it, by building more chambers and nurseries; so that the divisions, or columns between the future arched apartments resemble the pinnacles upon some old buildings, and demand particular notice, as affording one proof, that for the most part the insects project their arches, and do not make them by excavation. The subterraneous passages which run under the lowest apartments in the hill, in various directions, are of an astonishing size, being wider than the bore of a large cannon. These passages, or galleries, which are very thickly lined with the same kind of clay of which the hill is composed, ascend the inside of the external shell in a spiral manner, winding round the whole building up to the top, and intersecting each other at different heights; opening either immediately into the dome in various places, or into the interior buildings, the new turrets, &c., and sometimes communicating therewith by other galleries of different bores, or diameters, either circular or oval. From every part of these large galleries are various small pipes or galleries leading to different parts of the building. Under the ground there are a great many which lead downwards by sloping descents, three and four feet perpendicularly among the gravel; from this the labouring termites cull the finer parts, which being worked up in their mouths to the consistence of mortar, form that solid clay or stone of which all their hills and buildings, except the nurseries, are composed. Other galleries again ascend, leading out horizontally on every side; and are carried under-ground, near to the surface, a vast distance; for, if you destroy all the nests within a hundred yards of your house, the inhabitants of those which are unmolested farther off, will nevertheless carry on their subterranean galleries, and invade the goods and merchandise contained in it, by undermining them, and do great mischief, if they are not carefully watched.

The large galleries under the hills are the great thoroughfares for all the labourers and soldiers, going forth or returning upon any business whatever; whether fetching clay, wood, water, or provisions: and they are certainly well calculated for the purposes to which they are applied, by the spiral slope which is given them; for if they were upright, the labourers would not be able to carry on their building with so much facility, as they ascend perpendicularly with great difficulty, and the soldiers can scarcely do so at all. It is on this account that a road like a ledge is sometimes made on the perpendicular side of any part of the building within their hill; this road is flat on the upper surface, and half an inch wide, ascending gradually like a staircase, or like those roads which are cut on the sides of hills and mountains, which would otherwise be inaccessible: by this and similar contrivances, they travel with great ease to every internal part. This, too, is probably the cause of their building a kind of bridge, of one large arch, which answers the purpose of a flight of stairs from the floor of the area to some opening on the side of one of the columns supporting the large arches, an arrangement which must shorten the distance exceedingly to those labourers who have to carry the eggs from the royal chamber to some of the upper nurseries; a distance which in some hills would be four or five feet in the most direct line, and much more if carried through all the winding passages leading through the inner chambers and apartments. One of these bridges, of an elliptic form, was found to measure half an inch in breadth, a quarter of an inch in thickness, and ten inches in length. It was strengthened by a small arch at the bottom; and the footway on its upper surface was grooved throughout its entire length, either for the purpose of affording greater security to the labourers passing over it, or from being so worn by their constant treading.

The diligence of these little creatures in building is very remarkable. If any accident happen to their various structures, or they are dislodged from any of their covered ways, they get out of sight as soon as possible; for they run with great swiftness: and in a single night they will restore a gallery of three or four yards in length. If the nest is mutilated and thousands of apartments opened, all will be shut up with sheets of clay by the next morning. And even if the whole be demolished, provided the king and queen be left, every opening between the ruins, at which either cold or wet can possibly enter, will be covered, and in a year the building will be raised nearly to its original size and grandeur.

Besides building and repairing, many alterations are often required in the mansion and its approaches. The outside of the nest receives daily additions, to provide for a daily increasing population; and the direction of the covered ways must often be varied when the old stock of provisions is exhausted and a new stock discovered. The collection of provisions for the use of the colony is another employment which calls for incessant activity.

The prudence and good management of these insects are remarkably exhibited in their division of labour. Each set of insects has its own duties, with which the others never interfere. When the nest is attacked, and the walls injured, the labourers, who are incapable of fighting, retire within, and the soldiers, whose special duty it is to defend the fortress, rush out. If the damage is only slight, a single soldier comes out to reconnoitre; he then retires, and gives the alarm; two or three others next appear, scrambling as fast as possible one after the other; then follows the main body of warriors in continually increasing numbers. Their rage and fury are ungovernable; being blind, they bite everything they run against, and in their haste frequently tumble down the sides of their hill. If the attack on the nest is continued, the fury and agitation continue to increase. If they catch hold of any one's hands or legs they make their fanged jaws meet at the very first stroke, drawing blood, and not quitting their hold even though pulled limb from limb. But if the first attack is not renewed, and the assailant is gone away, the soldiers retire, and the labourers are in motion, hastening in various directions towards the breach, each carrying in his mouth a mass of ready-tempered

JAWS OF SOLDIER, (*magnified.*)

mortar, half as big as his body, which hardens into a solid substance, resembling stone, of which the nests are constructed. As fast as they come up, each strikes its burden upon the breach, and this is done with so much ease and regularity, that although millions be employed they never appear to embarrass or interrupt one another. Thus the wall soon rises, and the breach is repaired.

The soldiers are soon out of sight, except here and there a solitary one, who wanders about among the labourers, but does not assist in the work. One in particular places himself close to the wall they are building, and turning himself leisurely on all sides, appears to act the part of overseer. Every now and then he lifts up his head, and striking with his forceps upon the wall of the nest makes a particular noise, which is answered by a loud hiss from all the labourers, and appears to be a signal for despatch, for every time it is heard they redouble their pace, and work with increased diligence. As often as the attack is renewed the same course is taken: in rush the labourers, and out march the military, numerous and vindictive as before; and when all is quiet the labourers again appear, and resume their work, while the soldiers retire; and whatever be the peril or emergency, the labourers never attempt to fight, or the soldiers to work.

The termites are very destructive creatures, and are often regarded as a real calamity in both the Indies. They generally make their approaches to the nest under ground, descending below the foundations of houses and stores, at several feet from the surface, and rising again either in the floors, or entering at the bottoms of the posts, of which the sides of the buildings are composed, bore quite through them, following the course of the fibres to the top, or making lateral perforations and cavities here and there as they proceed. While some are employed in gutting the posts, others ascend from them, entering a rafter or some other part of the roof. If they once find the thatch, which seems to be a favourite food, they bring up wet clay, and build their pipes or galleries through the roof in various directions, as long as it will support them; sometimes eating the palm-tree leaves and branches, of which it is composed, and perhaps (for variety seems very pleasing to them) the rattan, or other running plant, which is used as a cord to tie the various parts of the roof together, and that to the posts which support it: thus, with the assistance of the rats, which during the rainy season are apt to shelter themselves there, and to burrow through it, they very soon ruin the house by weakening the fastenings and exposing it to the wet. In the meantime the posts will be perforated, in every direction, as full of holes as the timber in the bottoms of ships which have been bored by the worms; the fibrous and knotty parts being left to the last.

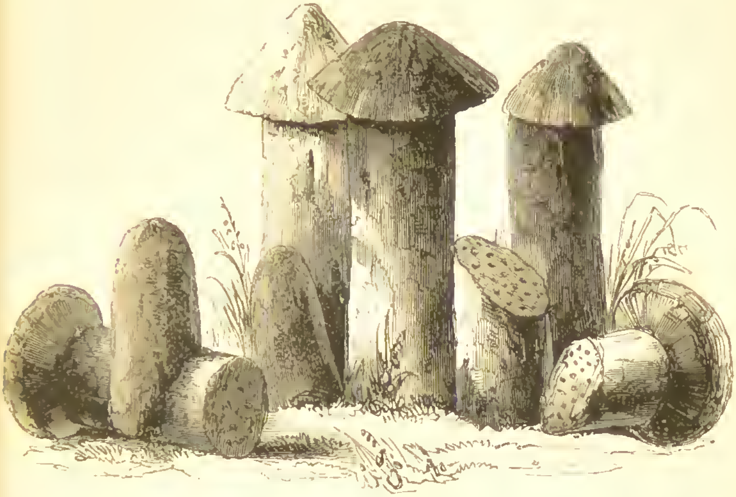
In carrying on this business, they sometimes find, by some means or other, that the post has a certain weight to support, and then, if it is a convenient track to the roof, or is itself a kind of wood agreeable to them, they bring their mortar, and as fast as they take away the wood, replace the vacancy with that material, which is worked together by them closer and more compactly than human strength or art could ram it. When the house is pulled to pieces, the posts formed of the softer kinds of wood are often found reduced almost to a shell, and all or most of them transformed from wood to clay, as solid and as hard as many kinds of freestone used for building in England. It is much the same when the termites get into a trunk containing clothes: if the weight above is great, or they are afraid of ants or other enemies, they carry their pipes through, and replace a great part with clay, running their galleries in various directions. Mr. Smeathman having left a microscope in a warehouse at Tobago for a few months, found on his return, that a small species (the tree termites) had established themselves within it, and had devoured most of the wood-work, leaving little besides the metal and the glasses. Another party had taken a liking to the staves of a Madeira cask, and had let out almost a pipe of fine old wine.

These creatures are not less expeditious in destroying the shelves, wainscoting, and other fixtures of the house, than the house itself. They are constantly engaged in piercing and boring in all directions, and sometimes go out of one post into another joining it; but they destroy the softer substances first, and are particularly fond of pine and fir-boards, which they excavate and carry away with wonderful despatch and cunning; for unless a shelf has something standing upon it, such as a book, or some other edible substance, they will not perforate the surface, but artfully preserve it quite whole, and eat away all the inside, except a few fibres, which barely keep the two sides connected together, so that a piece of an inch board which appears solid to the eye, will fall down under the smallest weight placed upon it. In short, the termites are so insidious in their attacks, that it is scarcely possible to guard against them. They will sometimes begin and raise their works, especially in new houses, through the floor. If the work thus begun is destroyed, and a fire kindled on the spot, they will the next night attempt to rise through another part; and if they happen to emerge under a chest or trunk early in the night, they will pierce the bottom and destroy or spoil every thing in it before the morning. Kampfer, speaking of the white ants of Japan, gives a remarkable instance of the rapidity with which these miners proceed. Upon rising one morning he observed that one of their galleries of the thickness of his little finger had been formed across his table, and upon a further examination, he found that they had bored a passage of that thickness up one foot of the table, formed a gallery across it, and then pierced down another foot into the floor: all which was done in a few hours. They will devour in one night all the boots and shoes that are left in their way; cloth, linen, books, and writing-paper, are equally to their taste; and hence throughout all the warmer parts of equinoctial America, where these and other destructive insects abound, it is extremely rare to find papers which extend fifty or sixty years back.

When the termites attack trees and branches in the open air, they proceed according to circumstances. If a stake in a hedge has not taken root and vegetated, it becomes their business to destroy it. If it has a good sound bark round it, they will enter at the bottom, and eat all but the bark, which will remain, and have the appearance of a solid stick, which some vagrant colony of ants or other insects often shelter in, till the winds disperse it; but if they cannot trust the bark, they cover the whole stick with their mortar, and it then looks as if it had been dipped into thick mud. Under this covering they work, leaving no more of the stick and bark than is barely sufficient to support it, and frequently not the smallest particle, so that, upon a very small tap with your walking-stick, the whole stake, though apparently as thick as your arm, and five or six feet long, loses its form, and disappearing like a shadow, falls in small fragments at your feet. They generally enter the body of a large tree, which has fallen through age, or been thrown down by violence, on the side next the ground, and eat away at their leisure within the bark, without giving themselves the trouble either to cover it on the outside or to replace the wood which they have removed from within, being by some means sensible that there is no necessity for it. "These excavated trees," says Mr. Smeathman, "have deceived me two or three times in running; for, attempting to step two or three feet high, I might as well have attempted to step upon a cloud, and have come down with such unexpected violence that, besides shaking my teeth and bones, I have been thrown head-foremost among the neighbouring trees and bushes. Sometimes, though seldom, the termites are known to attack living trees; but not, I apprehend, before symptoms of decay have appeared at the roots, since it is evident, that these insects are intended in the order of nature to hasten the dissolution of such trees and vegetables as have arrived at their greatest maturity and perfection, and which would by a tedious decay serve only to encumber the face of the earth. This purpose they answer so effectually that nothing perishable escapes them; and it is almost impossible to leave any thing penetrable upon the ground a long time in safety; for the odds are that, put it where you will abroad, they will find it out before the following morning, and its destruction follows very soon of course. In consequence of this disposition, the woods never remain long encumbered with the fallen trunks of trees or their branches; and thus it is, as I have often observed, the total destruction of deserted towns is so effectually completed, that in two or three years a thick wood fills the space; and unless iron-wood posts have been made use of, not the least vestage of a house is to be discovered."

Mr. Smeathman describes another species of white ants, smaller than the preceding, which construct nests of a very different form, the figures of which resemble a pillar with a large mushroom for a capital.

These turrets are composed of well-tempered black earth, and stand about three feet high. The conical roof is of the same material, and the brims hang over the column. Most of them resemble in



TURRET NESTS OF WHITE ANTS.

shape the body of a round windmill, but some of the roofs have little elevations in the middle. When one of these turrets is completed, the insects do not afterwards enlarge or alter it; but if it be found to be too small, they build another at a few inches distance. They sometimes begin a second before the first is finished, and a third before they have completed the second. Five or six of these singular turrets in a group may be seen in the thick woods at the foot of a tree. They are so strongly built, that in case of violence they will sooner tear up the gravel and solid heart of their foundation, than break in the middle. When any of them happen to be thus thrown down, the ants do not abandon them;

but, using their overturned column as a basis, they run up another perpendicularly from it, to the usual height, fastening the under part at the same time to the ground, to render it the more secure. This form is represented in the engraving.

The interior of one of these turrets is divided into innumerable cells of irregular shape. One of the turrets is represented in the figure as being cut through, with the upper part lying on the ground.

There is also a species of white ant which inhabits the interior of the trunks of trees, the wood of which they carve out into galleries. They feed upon the wood, but are careful not to injure the bark, which affords them protection. Another species builds a nest on the exterior of trees. It is of a globular or oval shape, occupying the arm or branch of a tree, sometimes from seventy to eighty feet from the ground, and as large in some instances as a sugar-cask. The composition used for building consists of the gnawings of wood in very small particles, kneaded into a paste with some kind of cement or glue. With this they form their cells in very large numbers. They are so firmly built, and so strongly attached to the trees, that they will resist the most violent tornado. It is impossible to remove them, except by cutting them in pieces or sawing off the branch, which is frequently done to procure the insects for young turkeys. A small specimen of one of these nests is shown in the frontispiece.—(P. 208.)

The several species of termites hitherto noticed have a strong aversion to work in the light, so that it is difficult to trace them even when they are numerous. Mr. Smeathman has, however, noticed a species which he calls *marching termites*, which do not construct covered ways to shelter them in their journeys. He says :—

"One day, having made an excursion with my gun up the river Camerankoes, on my return through the thick forest, whilst I was sauntering very silently in hopes of finding some sport, on a sudden I heard a loud hiss, which, on account of the many serpents in these countries, is a most alarming sound. The next step caused a repetition of the noise, which I soon recognised, and was rather surprised, seeing no covered ways or hills. The noise, however, led me a few paces from the path, where, to my great astonishment and pleasure, I saw an army of termites coming out of a hole in the ground, which could not be above four or five inches wide. They came out in vast numbers, moving forward as fast, seemingly, as it was possible for them to march. In less than a yard from this place they divided into two streams or columns, composed chiefly of the first order, which I call labourers, twelve or fifteen abreast, and crowded as close after one another as sheep in a drove, going straight forward without deviating to the right or left. Among these here and there one of the soldiers was to be seen, trudging along with them in the same manner, neither stopping nor turning ; and as he carried his enormous head with apparent difficulty, he put me in mind of a very large ox amidst a flock of sheep. While these were trotting along, a great many soldiers were to be seen spread about on both sides of the two lines of march, some a foot or two distant, standing still or sauntering about as if upon the look-out lest some of the enemy should suddenly come upon the labourers ; but the most extraordinary part of this march was, the conduct of some others of the soldiers, who having mounted the plants which grew thinly here and there in the thick shade, had placed themselves upon the points of the leaves, which were elevated ten or fifteen inches above the ground, and hung over the army marching below. Every now and then one or other of them beat with his forceps upon the leaf, and made the same sort of ticking noise which I had so frequently observed to be made by the soldier who acts the part of a surveyor or superintendant, when the labourers are at work repairing a breach made in one of the common hills of the Termes bellicosi. This signal among the marching white ants produced a similar effect ; for whenever it was made, the whole army returned a hiss, and obeyed the signal by increasing their pace with the utmost hurry. The soldiers who had mounted aloft and gave these signals, sat quite still during the intervals (except making now and then a slight turn of the head,) and seemed as solicitous to keep their posts as regular sentinels. The two columns of the army joined into one about twelve or fifteen paces from their separation, having in no part been above three yards asunder, and then descended into the earth by two or three holes. They continued marching by me for above an hour that I stood admiring them, and seemed neither to increase nor diminish their numbers, the soldiers only excepted, who quitted the line of march and placed themselves at different distances on each side of the two columns; for they appeared much more numerous before I quitted the spot."

In dismissing the history of the ants, whether of our own or of other climates, we may use the language of the first accurate historian* of these insects, who thus enumerates the "instructions" which may be gained from a colony of them.

"Their surprising affection towards their young might teach us to value posterity and promote its happiness. The obedience they pay their respective queens might read us a lecture of true loyalty and subjection. Their incessant labours may serve to enliven the industrious, and shame the lazy part of mankind. The unanimous care exerted by each colony for the common emolument might let us know the consequence of public good, and tempt us to endeavour the prosperity of our own countrymen. From their economy we may learn prudence; from their sagacity wisdom. If, lastly, we call to mind the infinite curiosities that distinguish a settlement of ants; the form and structure of the common workers; the glorious character of the queen; the strange unparalleled circumstances that attend the flies; the remarkable changes of the young; the different species and particular use they answer in the scale of beings; we cannot but extol the majesty of God, who has arrayed the universe with so much beauty, and embellished each part of it with such a scene of wonders. 'Great is the Lord, and marvellous, worthy to be praised; there is no end of his greatness.' Psalm cxlv. 3."

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* Rev. W. Gould, M.A. Account of English Ants, 1747.

The Spider's touch, how exquisitely fine!
Feels at each thread, and lives along the line.

THE SPIDER,

AS AN EXAMPLE OF PERSEVERANCE.

IN endeavouring to secure the good, and to avoid the evil, which are so largely to be met with in the world, few qualities are of more value than PERSEVERANCE, or steady continuance in one course of action. We find that all the best and most lasting works of man are accomplished by perseverance. By this, the shapeless stones of the quarry are raised into a city of houses and churches ; by this, the bog and the morass are changed into fields of smiling corn ; and distant places are united by good roads. It is this that brings us the useful products of distant countries, and that carries abroad to heathen lands the blessings of civilization. "And yet," says one of our old writers, "if a man was to compare the effect of a single stroke of the pick-axe, or of one impression of the spade, with the general design and last result, he would be overwhelmed by the sense of their disproportion ; yet those petty operations, incessantly continued, in time surmount the greatest difficulties,—and mountains are levelled and oceans bounded by the slender force of human beings."

But what is of more importance to us, as individuals, than the building of cities or the traversing of seas, is that by perseverance good habits are formed and bad ones overcome; and there is no better way of overcoming a bad habit than by cultivating a good one to take its place. Many persons are disposed to begin a good course, but few have courage to persevere. It is easy to say what we will do, but not so easy to use the necessary effort and self-denial. These become irksome and tiresome, and are gradually given up and abandoned.

Meanwhile the persevering are able to overcome difficulties, and to accomplish ends which would seem impossible to other men. Experience teaches them that difficulty flies before them as they advance; for they are like the traveller who in his journey saw nothing but a mountain wall before him, which seemed to oppose all farther progress, but by persevering in his course, discovered a path before unseen opening among the hills.

If there are times when the most indolent feel the value of perseverance, and wish it were in their power to exercise it, perhaps they may be shamed, if they cannot be won, to the attempt by considering the example of one of the humblest of God's creatures. We have been commanded, "Ask now the beasts, and they shall teach thee; and the fowls of the air, and they shall tell thee." (Job xii. 7.) And there are many beasts and birds capable of giving a useful lesson on perseverance; but on this occasion our example will be taken from a still humbler class of animals. THE SPIDER, a creature usually regarded with dislike, if not with dread, may yet afford a remarkable proof of the power of perseverance in overcoming difficulties. The beautiful webs hung on the foliage in the early summer's morn, dotted with dew, and sparkling in the sun ; or the same silken threads, strung by the hand of winter with pearls glittering in the light of day, are not merely beautiful objects indicative of the skill of the creature that could form such exquisite net-work, but are examples of patient and persevering toil, that may well make the indolent man blush.

If a king once did not disdain to learn a useful lesson of perseverance from a spider, why should we despise a similar instructor? It is related that Robert the Bruce, king of Scotland, deprived of his crown and banished from his country, "was lying, one morning, on his wretched bed, and deliberating with himself whether he had not better resign all thoughts of again attempting to make good his right to the Scottish crown, and dismissing his followers transport himself and his brothers to the Holy Land, and spend the rest of his life in fighting against the Saracens. But then, on the other hand, he thought it would be both criminal and cowardly to give up his attempts to restore freedom to Scotland, while there yet remained the least chance of success.

"While he was divided betwixt these reflections, and doubtful of what he should do, Bruce was looking upward to the roof of the cabin in which he lay, and his eye was attracted by a spider, which, hanging at the end of a long thread of his own spinning, was endeavouring, as is the fashion of that creature, to swing himself from one beam in the roof to another, for the purpose of fixing the line on which he meant to stretch his web. The insect made the attempt again and again without success; and, at length, Bruce counted that it had tried to carry its point six times, and been as often unable to do it. It came into his head that he had himself just fought six battles against the English and their allies; and that the poor persevering spider was exactly in the same situation with himself, having made as many trials, and been as often disappointed in what it aimed at. 'Now,' thought Bruce, 'as I have no means of knowing what is best to be done, I will be guided by the luck which shall attend this spider. If the insect shall make another effort to fix its thread, and shall be successful, I will venture a seventh time to try my fortune in Scotland; but if the spider shall fail, I will go to the wars in Palestine, and never return to my native country again.'

"While Bruce was forming this resolution, the spider made another exertion with all the force it could muster, and fairly succeeded in fastening its thread to the beam which it had so often in vain attempted to reach. Bruce, seeing the success of the spider, resolved to try his own fortune; and as he never before gained a victory, so he never afterwards sustained any considerable check or defeat. I have often met with people of the name of Bruce," says the writer of this anecdote,* "so completely persuaded of the truth of this story, that they would not on any account kill a spider, because it was such an insect which had shown *the example of perseverance*, and given a signal of good luck to their great namesake."

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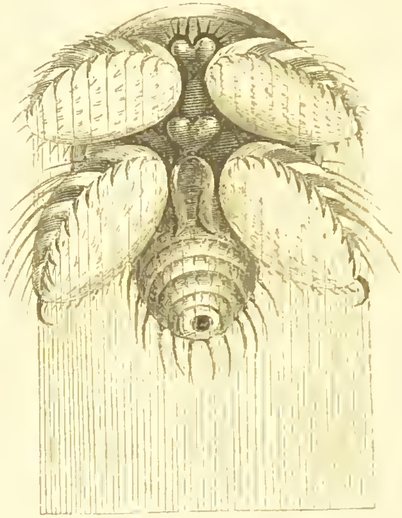
* Sir Walter Scott.

Let us, then, inquire into the history of the spider, which of itself reveals much that is beautiful and interesting, and endeavour to gather lessons of industry and perseverance from its habits and mode of life.

Spiders are sometimes ranked among insects; but they differ from them in several respects; especially in not being subject to those changes of form and of habit which make insects appear like so many distinct beings in different parts of their lives. There are many different kinds of spiders, having different habits of life and different methods of taking their prey; but they all show the same art and perseverance in providing for themselves and for their young. The greater number weave curious and beautiful webs, to entangle flies and other small insects. But there are some spiders which never make webs, but either hunt their victims, or lie in ambush for them in holes in the earth, in crevices of walls or trees, or even in the cup of a flower.

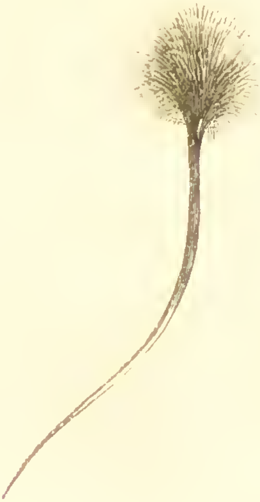
The net-weaving spiders are the best known; therefore we shall first consider what are their working materials and what their working tools.

The thread spun by these spiders is like that produced by the silkworm and other caterpillars, except that it is much finer in quality. It is produced within the body of the animal as a thick gum, and issues out through four or six little swellings on the abdomen: these form the spinning apparatus, and produce the thread somewhat in the manner of rope-spinning. Each spinner contains an immense number of fine tubes; every one of which consists of two parts, the last being pointed, and from all these points proceed threads of wonderful fineness, which, as soon as they issue out, are immediately united into one thread. The compound threads thus produced by each spinner, when about an inch long, are again united to form the thread used by the spider in making its web. The tubes from which the threads are first produced are not all of the same size, and therefore the threads are not all of the same thickness. But it is a very wonderful fact. that a spider's thread, even when so fine as to be



SPINNERETS OF A SPIDER, GREATLY MAGNIFIED.
(showing how a single thread is produced from the various spinnerules.)

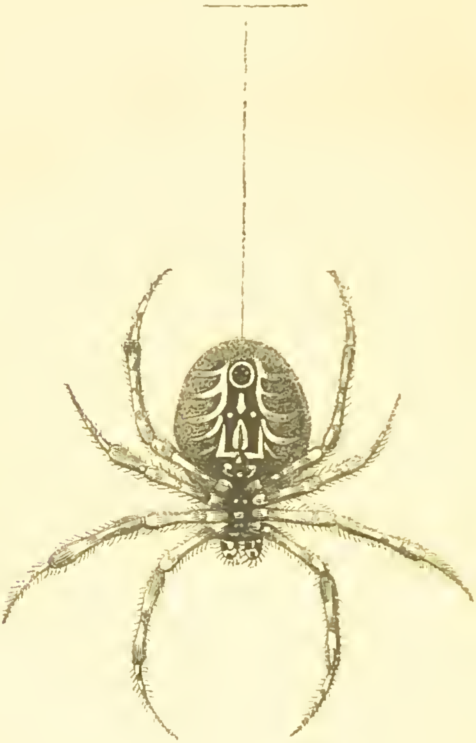
scarcely visible by us, is not a single line, as we generally suppose, but a rope composed of not less



THE END OF A SPIDER'S THREAD ATTACHED TO A SURFACE:
(*magnified.*)

than four thousand strands! And this is true for spiders not larger than a grain of sand, as well as for the largest specimens. Thus the spider makes threads of any desired thickness; and in order to ensure their strength, first dries the silk in numerous minute threads, and then spins these threads into one. She is also gifted with the power of closing the spinners at pleasure; and thus the spider's line serves the same useful purpose as the wings of a bird,—for by throwing herself down from a height by her line, she can stop her progress at any point of the descent.

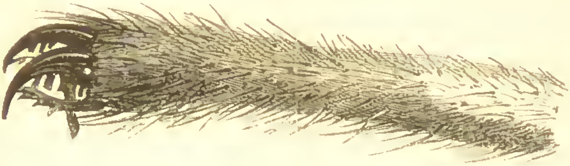
The claws of the spider's feet are of great assistance in weaving the thread, being furnished in



GARDEN SPIDER SUSPENDED BY A THREAD FROM THE SPINNERET.

many species on the under surface with teeth like a comb ; with this instrument she usually guides, or keeps separated into two or more, the line from behind. The foot is also furnished with a third claw, upon which the spider, in ascending her line, winds up into a ball all the superfluous silk. This remarkable structure was evidently known to

Solomon, the wisest of kings, when he wrote, "The spider *taketh hold with her hands,* and is in kings' palaces." (Prov. xxx. 28.) But there is



CLAWED FOOT OF THE SPIDER.

also another provision, by which the spider is able to walk upon glass, or other slippery surfaces, without danger of falling. The under surface of the foot in a great number of spiders, is furnished with a thick brush formed of slender bristles, fringed on each side with exceedingly fine hairs. This was first seen in the bird-spider, and may be noticed by the aid of a microscope in any of the common spiders that climb our windows.

The situations which spiders select for hanging their nets are various. Some prefer the open air, amid shrubs or plants, where flies find both food and sport. Other spiders lodge in the corners of windows or rooms, where they are sure of prey; many weave their nets in stables and out-houses, and even in cellars and deserted places, which would scarcely seem to afford a single fly. Indeed, where the busy hum of man is not heard, and where the labours of the housewife are not seen, the spider loves to take up her solitary abode. Mr. Kirby says that "the Jews, in one of the fables with which they have disfigured the records of Holy Writ, relate that the reason why Saul did not discover David and his men in the cave of Adullam (1 Sam. xxiv. 4), was that God had sent a spider, which had quickly woven a web across the entrance of the cave in which they were concealed; which being observed by Saul, he thought it useless to investigate further a spot bearing such evident proofs of the absence of any human being."

Mr. Jesse has recorded an instance where two spiders formed their webs within a drawer, and continued to occupy the opposite corners of it for *thirteen* years. During the whole of that time the drawer was used exclusively for soap and candles, and was always kept closed and locked except when opened to put in or take out those articles. The spiders were constantly in the same position, in a hole in the inner corner of their webs, and seldom showed more of themselves than their two fore legs projecting outwards.

Most persons will have remarked the difference between the web of the spider which inhabits the house, and that which seeks its prey in the garden. The former is a *weaver*, her web being of a gauze-like texture, as if woven; but to the latter has been given the grander title of *geometrician*, from the circumstance that it forms, not a web, but a net composed of a series of concentric circles, united by radii diverging from the centre, the threads being remote from each other.

The weaving spider, in beginning her web, often chooses the corner of a room, and takes care to secure a retreat should she be assailed by a powerful enemy. She first presses her spinners against one of the walls, thus glueing to it one end of the thread. She then walks along the wall as far as the opposite limit of the web, while the thread lengthens behind her, and there fastens the other end, pulling it in order to be sure that it is tight. As this thread is to form the outer margin or selvage of the web, it is strengthened by two or three more threads drawn along it, and fixed like the first. From this outer line she draws other threads in various directions, filling up the intervals by running from one to the other, and connecting them by new threads until the whole rapidly assumes that gauze-like texture so well known in every house.

These webs present merely a simple flat surface; but to those which are found in out-houses, or among bushes in the open air, a very ingenious addition may be noticed. From the edges and surface of the main web, the spider carries up a number of single threads often to the height of many feet, joining and crossing each other in various places. These lines are not unlike the tackling of a ship, and the flies seem unable to avoid directing their flight across them; when, becoming slightly entangled, they make desperate efforts to escape, which generally have the effect of throwing them into the web stretched below for their reception, when their doom is fixed.

But the net is not yet complete. The spider next makes a small silken apartment below the net, and quite out of sight, where she waits for the expected game; and that she may know when any is caught, a number of threads proceed from the edge of the net to that of her den, which, by their trembling, inform the spider that a fly is caught, and at the same time serve as a bridge, over which she can instantly pass to secure it.

The GEOMETRIC SPIDER usually suspends her net from trees, shrubs, plants, or buildings, in places where insects abound. Her first operation, in most instances, is to form boundary lines so as to enclose an area, the figure of which appears to be a matter of indifference; for the little geometrician seems to be well aware that she can as readily describe a circle in a triangle as in a square. She forms these boundary lines by proceeding along the objects immediately surrounding the space destined to be occupied by the net, and attaching to several points a line drawn out after her in her passage from one to another. She strengthens these lines with a few additional ones, and finally makes them tight by fixing in different directions numerous smaller threads. Having thus completed the foundations, she next begins to fill up the outline. Fixing a thread to one of the boundary lines, along which she walks, she guides the filament produced in her progress with one of her hind feet, that it may not touch in any part and adhere prematurely, and crossing over to the opposite side, she there attaches it firmly. To the middle of this diagonal thread, which is to form the centre of the net, she fixes a second, which, in like manner, she conveys and fastens to another part of the lines encompassing the area. Along this last-formed thread she returns, drawing out another after her, which, as she does not employ any means to keep it distinct, becomes connected with that on which she is advancing, and is at last glued by its extremity to the centre of the net. In this manner, but without observing any regular order in her progress, she forms about twenty or thirty rays composed of double lines, passing from the centre to the circumference, and giving the net the appearance of a wheel. She then proceeds to the centre, turns herself round, and pulls each ray with her feet to ascertain its strength, breaking such as seem defective, and replacing them by others. She then produces, round the centre of the net, a spiral line, extending thence to the circumference, and intersecting the rays at distances gradually widening from the centre, attaching it to them by pressing her spinners against them. This spiral line serves as a temporary scaffolding for the spider to walk over, and also to keep the rays properly stretched during her succeeding operations. The spiral line, the rays, and the marginal lines, are all composed of adhesive silk; but a spiral line has now to be spun from the circumference around the centre, which may be regarded as the most important part of the snare. It consists of a fine thread, closely studded with minute dew-like globules, which are of a gummy nature, as is proved by their adhering to the finger, and retaining dust thrown upon the net, while the other rays and threads remain unsoiled. These viscid threads alone retain the insects which fly into the net, and as they lose their adhesive property by the action of the air, it is requisite that they should be frequently renewed,—a process not neglected by the spider, who is quite conscious of its necessity. Placing herself at the circumference of the net, and fastening her viscid thread to the end of one of the rays, she walks up towards the centre, till she comes to the last turn of the unadhesive spiral line, along which she passes to the adjoining ray, at the same time drawing out the thread with the claws of the hind leg nearest to the circumference. She then passes the thread to the claws of the other hind leg, and going down the ray towards the circumference, she places the foot of the unemployed hind leg on that point of the ray to which her thread is to be attached, and bringing the spinners to the spot, there makes it secure. The precise place in each ray at which to fix the thread is always ascertained by touching with the hind feet the marginal line, or the last-formed turn of the viscid spiral line. As this last line approaches the several turns of the unadhesive spiral line, the spider bites away the latter, being sensible that they are no longer of any use to her ; and this fact explains why they are never seen intermixed with the turns of the former in finished nets. The spider now makes choice of some retired spot in the vicinity, and there constructs a cell, in which she may conceal herself from observation. From the centre of the net to this retreat she spins a line of communication, composed of several threads united together throughout the whole length, the vibrations of which speedily inform her of the capture of her prey; and here her labours end.

Mr. Foster, in the *Entomological Magazine*, relates a singular contrivance of the small garden-spider. "She had formed her web over the middle of a gravel path, attaching the supporting threads to the paling on one side, and to a sun-flower on the other. The breeze was rather strong, and to keep her web steady, she had drawn up a small gravel stone, though very nearly the size of her own body, which hung beautifully poised between two threads, about a foot above the path, and which answered the purpose she wished most admirably well; it swung backwards and forwards with the motion of the wind, but still was heavy enough to keep her web distended and steady." This circumstance has been noticed by other naturalists, but explained somewhat differently. The spider makes choice of a pebble in a gravel path as one of the *fixed* points for attaching the boundary lines; but as the work proceeds, the tension of the upper lines actually lifts the stone from off the ground, and being thus delicately hung like a pendulum, it swings to and fro in the breeze.

The spider has as yet been described only as forming her snare in places of easy access; but it is not uncommon to see nets fixed to objects between which the animal could not, in the first instance, have walked; for example, between distant plants growing in water. How, then, does the spider contrive to extend her main line, which is often many feet in length, across a stream? In answer-ing this question, we have only to relate the surprising instances of patience and perseverance in this little animal, witnessed by the Rev. Mr. Kirby and other observers.

A large garden-spider was placed upon a stick, about a foot long, set upright in a vessel of water. After fastening its thread (as all spiders do before they move) at the top of the stick, it crept down the side until it felt the water with its fore feet, which seem to serve the same purpose in spiders as the antennæ or feelers in insects. The spider then immediately swung itself from the stick (which was slightly bent), and climbed up by the thread to the top. This it repeated, perhaps, twenty times, sometimes creeping down a different part of the mast, but more frequently down the very side it had so often traversed in vain. "Wearied with this sameness in its operations," says the narrator, "I left the room for some hours. On my return I was surprised to find my prisoner escaped, and not a little pleased to discover, on further examination, a thread extended from the top of the stick to a cabinet seven or eight inches distant. Eager to witness the process by which the line was constructed, I replaced the spider in its former position. After frequently creeping down and mounting up again as before, at length it let itself drop from the top of the stick, not as before by a single thread, but by *two*, each distant from the other about the twelfth of an inch, guided as usual by one of its hind feet, and one apparently smaller than the other. When it had nearly reached the surface of the water it stopped short, and broke off close to the spinners the smallest thread, which still adhering by the other end to the top of the stick, floated in the air, and was so light as to be carried about by the slightest breath." On bringing a pencil near the loose end of this line, Mr. Kirby found that it did not adhere from mere contact; he therefore twisted it once or twice round the pencil, and then drew it tight. The spider, which had previously climbed to the top of the stick, immediately pulled at it with one of its feet, and finding it sufficiently firm, crept along it, strengthening it as it proceeded by another thread, and thus reached the pencil.

This surprising proof of perseverance in overcoming difficulties is worthy of being kept in remembrance. It is an example that may be as useful to us as a less remarkable one was to Robert the Bruce. Scarcely less interesting is Mr. Blackwall's account of the gossamer spiders. These are the little creatures that make those floating webs seen in the air, or covering the surface of the ground, about the month of October. Several of these spiders were put on a small branched twig, placed upright in an earthen vessel of water. Whenever the insects were exposed to the slightest current of air, they directly turned themselves towards the quarter whence it came, and, elevating their spinners, they sent out a small portion of glutinous matter, which was instantly carried by the air into a line consisting of four finer lines. The spiders, in the next place, carefully ascertained whether their lines had become firmly attached to any object or not, by pulling at them with the first pair of legs; and if the result was satisfactory, after tightening them sufficiently, they made them fast to the twig; then applying their spinners to the spot where they stood, they discharged a little more liquid gum, and committing themselves to these bridges of their own constructing, they passed over them in safety, drawing a second line after them, as a security in case the first gave way, and so effected their escape.

Such was invariably the result when spiders were placed where the air was liable to be sensibly agitated; but on covering them over with a glass shade, they remained in this situation during seventeen days, evidently unable to produce a single line by which they could quit the branch they occupied without encountering the water at its base; though on the removal of the glass, they regained their liberty with as much speed as in the before-mentioned cases. Mr. Blackwall tried the same experiment with several geometric spiders, and always with the same success.

Another ingenious observer, Mr. Rennie, has recorded a series of experiments bearing upon the same point. He placed several spiders in empty wine-glasses, set in tea-saucers filled with water. When they discovered, by repeated descents from the brims of the glasses, that they were thus surrounded by a wet ditch, they all set to work to throw their silken bridges across it. For this purpose they first endeavoured to ascertain the direction of the wind, or rather which way any current of air set (as the experiment was tried in a room), by raising their arms as seamen are accustomed to do in calm weather. But it will be sufficient to notice the proceedings of one of the little band of prisoners, which was a gossamer spider.

Finding no current of air on any quarter of the brim of the glass, it seemed to give up all present hopes of constructing its bridge of escape, and placed itself in the attitude of repose, prepared to wait in patience for a breeze; but no sooner did Mr. Rennie produce a stream of air by blowing gently towards its position, than the little animal was up and stirring; it instantly fixed a thread to the glass, and laying hold of it with one of its feet by way of security, it placed its body in an upright position, with its spinnerets extended outwards; and immediately a thread was seen streaming out from them several feet in length, on which the little aeronaut sprung up into the air, and thus escaped.

In the formation of their nets spiders are regulated chiefly by the sense of touch, which they possess in high perfection.

> "The spider's touch, how exquisitely fine!
> Feels at each thread, and lives along the line."

They find out when they have the full number of rays by going to the centre and touching each in succession with the feet, supplying deficiencies wherever they are perceived. They also construct their snares as well in the dark as in the light; for spiders having been shut up in glass jars and placed in the dark, produced during their captivity nets of admirable workmanship.

The silken lines of the web are of various degrees of strength and elasticity; the rays and marginal lines have but little elasticity, but the viscid line possesses it to a remarkable degree, and is thus adapted to the frequent and rapid changes in distance that take place among the rays when the net is agitated by winds or other disturbances, while the insects that fly against it are more completely entangled than they otherwise could be without doing extensive injury to the framework of the snare. That they may find out whether the entangled flies are alive or dead, the geometric spiders pull the rays with their feet, and suddenly letting go their hold, produce by this means a vibratory motion in the net which seldom fails to rouse such insects as are ensnared. Guided by the struggles of her prey, the spider runs along the nearest ray to seize her victim, avoiding any contact with the viscid line as much as possible, and drawing out after her a thread attached to one of the lines near the centre of her net, which helps her return.

As the spider cannot pursue her prey, she has to exercise patience in waiting for what chance may bring to her net. Even in the busy insect districts of the fruit and flower garden, the geometric spider has often to undergo a long fast. Wet and windy weather may destroy all her webs, and prevent her from spinning others, perhaps for weeks; during all which time she is without food. And when at length a new net is formed, or the old one repaired, some bee or wasp, or large fly, too strong and bulky for the little geometrician, may get entangled in the snare, and reduce it to ruin in its efforts to escape. But all these accidents do not disturb the temper of the patient spider. She sits watching, without ever moving, until the lucky moment arrives when a manageable fly is caught. She is then all activity, and uses her utmost skill to prevent escape. If the insect be of small size, the spider conveys it at once to her hiding place; and having sucked out all the juice, throws out the carcase. If the insect should be too large to be directly attacked, the spider nimbly and skilfully coils a number of threads round its body in various directions, securing both its wings and legs; it is then conveyed to the den, and devoured at leisure.

Mr. Darwin notices a large spider common about Rio de Janeiro, which, when any large insect, such as a grasshopper or wasp, is caught, quickly gives it a revolving movement, and at the same time emits a band of threads from its spinners, thus enveloping its prey in a case like the cocoon of a silkworm. The spider now examines its powerless victim, and gives the fatal bite on the hinder part of its neck, and then retreating, it waits patiently until the poison has taken effect.

The patience of the spider in waiting, even with much fasting and self-denial, the moment when she may secure the most certain provision for her wants, is not unworthy the consideration of those who find it a hard and a difficult task to provide themselves with the common necessaries of life. Rash and imprudent measures are to be avoided, nor may cunning and deception be made use of to gain a temporary advantage. Dishonesty of any kind, whether in word or deed, is a sin against God, and a most foolish way of attempting to get forward in the world. Sooner or later the lie is found out, and the person who thus attempts to impose on his fellow-creatures is despised and mistrusted every where, while his own conscience, if not hardened by guilt, is a daily torment to him wherever he goes. It may seem hard to talk of patience to a hungry and a needy man; nor is it intended to recommend that sort of inactivity which is too often mistaken for patience. True patience is quite consistent with the faithful and persevering exercise of duty. Every thing that industry can do, must be done, not once, but again and again; and after all, a man will have need of patience to bear the many discouragements and disappointments of life. But it is only in the patient and persevering discharge of his duty that he can expect any advantage, either for this world or the next. There is such a thing as being industrious by fits and starts. Some men will work hard for a few days, and then indulge themselves in idleness and intemperance until all their wages are spent, and they are forced to go to work again. If such men would forego their bad habits, and persevere in their good ones, they would quickly find themselves much better off in the world, much happier in their families, and much more useful members of society. If they can work well and steadily for a few days, why not all the week? What pleasure is there that can equal a good conscience; and what comfort so great as that of a contented family and a happy home? But these unhappy men throw away all the real enjoyment of life for the sake of the noisy mirth of ale-house companions, and the excitement of strong drink. Such men usually come in their old age, if not before, to the lowest pitch of poverty and wretchedness, according to that inspired declaration, "The drunkard and the glutton shall come to poverty; and drowsiness shall clothe a man with rags." (Prov. xxiii. 21.)

The wonderful fact that the geometric spider is able to spin two different kinds of silk, one gummy and the other not, has not been explained; but it is obvious that these spiders must either have two distinct sets of spinners, of which one spins the gummy, and the other the unadhesive threads; or else, if all the threads proceed from the same spinners, the spider must have the means of passing the threads through a reservoir of gum at pleasure.

In renewing their webs, the geometric spiders are guided by the state of the atmosphere; and so delicate are their perceptions, that they make good weatherscopes. It is stated, that if the weather is about to be unsettled, wet, and stormy, the main threads which support the net will be short; but if fine settled weather is about to set in, these threads will be very long.

When larger booty is plentiful, these spiders seem not to regard smaller insects. "I have observed them in autumn," says Mr. Kirby, "when their nets were almost covered with the aphides which filled the air, impatiently pulling them off and dropping them untouched over the sides, as though irritated that their meshes should be occupied with such insignificant game. A species of spider, described by Lister, more provident than its brethren, suspends its prey in the meshes above and below the centre, and it is not uncommon to see its larder thus stored with several flies."

In addition to the weavers and geometricians, there are other kinds of spiders, which lay their snares each after its own fashion. One extends its large white net over blades of grass. Another spins a small net upon the upper surface of a leaf. A third spreads its snare under stones and in slight furrows in the ground, entrapping grasshoppers, which are said to be its principal food. Another variety conceals itself in a long, straight, silken tube, from the mouth of which it stretches out the fore-feet upon threads eight or ten inches long; so that no sooner does an insect walk across any of the threads, than the spider rushes out, and seldom fails to secure its victim. In all the arts and ingenious contrivances made use of by the spider to entrap insects, we must remember that it is following the law of nature, and is performing an important service to the human race. To ascribe to it the characters of cruelty and rapacity is most unjust.

This slight notice of net-weaving spiders may suffice to show how patient and persevering they are in their tasks; but perhaps there is even greater need for patience in the case of those spiders which do not entrap their prey in this manner, which never make nets, but adopt various arts and contrivances to catch the insects that may come near their holes. Yet these spiders are not without the power of producing nets, for they spin silken cocoons to contain their eggs, and often line their cells with silk.

Some of these conceal themselves and lie in wait for their prey, and sometimes run after it a short distance; others are constantly roaming about in every direction in search of it, and seize it by open violence ; others, again, catch their prey in water. Various are their arts and contrivances. Some pretend to be dead ; others select flowers and plants, the colour of which is like that of their own body, and thus they remain concealed, ready to dart upon the luckless fly that comes within reach.

Some of the hunting spiders of the tropics are of very large size, and will, it is said, devour birds, cockroaches, &c. Others hunt along the margin of pools, and sometimes venture to skate upon the surface of the water itself. In the fen ditches of Norfolk, a very large spider has been seen, which actually forms a raft of a ball of weeds, about three inches in diameter, which it appears to hold together by slight silken cords ; on this floating island it is wafted along the surface of the water, and the moment it discovers a drowning insect it seizes it, and devours it at leisure.

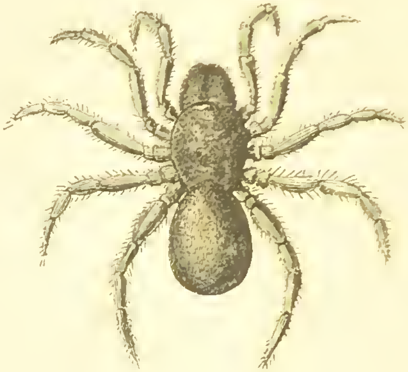
Some hunters seize their victims by leaping upon them. To this division belongs a very pretty small banded species, which in summer may be seen running on every wall. Some also actually seize their food by diving under the water, their bodies being kept from wet by a coating of air which constantly surrounds them. "Thus one single race of insects exemplifies in miniature almost all the modes of obtaining food which prevail amongst predaceous quadrupeds—the audacious attack of the lion, the wily spring of the tiger, the sedentary cunning of the lynx, and the amphibious dexterity of the otter."

Thus we have seen the perseverance of the spider exercised in a variety of ways, for the all-important object of procuring food; but there is still another and a very remarkable way in which the same quality is employed for the sustenance and preservation of her young. It may seem strange that animals of this kind, which devour live insects, and even their own species among the rest, should yet be possessed of the gentler feelings: yet such is the case. There is a spider often found under clods of earth, having a white globular silken bag of eggs, about the size of a pea, attached to her body. She clings to this bag with the greatest fondness; and though it is rather heavy, she carries it with her everywhere. If deprived of it, she makes the most desperate efforts for its recovery; and will brave any danger rather than desert her precious load. If all her efforts are ineffectual, and she is deprived of this first object of her cares, life itself appears to have lost its charms, and she pines in a stupid kind of melancholy. But if she regains the bag, her eagerness in seizing and running off with it proves the excess of her joy. This wonderful attachment was once put to an affecting and decisive test. Bonnet, the naturalist, threw a spider with her bag into the hole of a large ant-lion, a ferocious insect, which conceals itself at the bottom of a conical hole constructed in the sand, for the purpose of catching its prey. The spider endeavoured to run away, but could not prevent the ant-lion from seizing the bag of eggs, which it attempted to pull under the sand. She struggled with all her might, but the gluten which fastened her bag at length gave way, and it separated. The spider then instantly caught hold of it with her jaws, and endeavoured, but in vain, to rescue the prize. The ant-lion was the stronger of the two, and, in spite of all her struggles, dragged the object of dispute under the sand. The unfortunate mother might have preserved her own life from the enemy; she had but to give up the bag and escape out of the pit; but maternal affection induced her to persevere to the end. She preferred allowing herself to be buried alive rather than part with her treasure; and it was only by force that Bonnet, at length, withdrew her from the unequal conflict. But the bag of eggs remained with the ant-lion; and although Bonnet pushed her repeatedly with a twig of wood, she still persisted in continuing on the spot. Life seemed to have become a burden to her, and all her pleasures to have been buried in the grave which contained the germ of her progeny.

The attachment of this affectionate mother is quite as remarkable when the young spiders are hatched. They make their way out of the bag by an opening which she provides for them; and then, like the young of the Surinam toad, they attach themselves in clusters upon different parts of her body; and in this situation she carries them about with her, and feeds them, until their first moult, when they are big enough to provide for themselves. While the young spiders thus cover, by hundreds, the body of the mother, it is described as most amusing to see them, on the slightest alarm, leap from her back and run away in every direction.

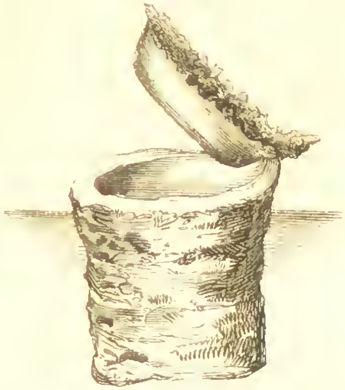
Here we have, indeed, a very striking example of parental affection, and one from which we may, perhaps, gather a useful lesson. The spider is not only ready to lay down her life for her young, but she also exhibits the most persevering care for their safety during the whole time in which they are unable to provide for themselves. She carries them about with her, feeds them, and watches over them continually. In like manner the human parent feels a natural and powerful love for his family, and would suffer much to defend them from harm. But since his children are gifted with reason, and with souls that will never die, it is very plain that his duties are much more important than those of the lower animals. It is, indeed, his duty to feed and clothe, and shelter them, to take care of their health, and to keep them out of all danger that may happen to their bodies ; but he has also to provide against those evils which may assault and hurt their souls. And how can he do this but by setting them a good example, by praying to God to bless them, by teaching them to read and to love the Bible, by taking them to the house of God, and by making them, to the best of his power, obedient, loving, dutiful children, useful to their parents, diligent in their tasks, and willing to earn their own living, and to do their duty in that state of life to which it has pleased God to call them? Such children are a blessing, while an unruly, disobedient family is a curse. But in this matter so much depends on the parents, that we never see a riotous or a slovenly household without feeling that the children themselves are not so much to blame as those who have thus sadly neglected to teach them their duty. Children usually learn most from the mother, at least during their early years; and it is sad indeed to observe how many mothers among the poorer classes are sluttish in their habits, and discontented and peevish in their tempers. From such mothers many are the blows and the violent words received by the children on the least offence, and great and lasting is the injury thus inflicted. Those children practise the same tyranny, and copy the same language among their playfellows, and grow up to be quarrelsome neighbours and misgoverning parents in their turn. The early training, whether bad or good, is often to be discovered in the conduct through life. Therefore, deeply important is the command, "Train up a child in the way he should go; and when he is old, he will not depart from it." (Prov. xxii. 6.)

There is a burrowing spider, which, by means of her strong jaws, forms a sort of tube or gallery, under ground, more than two feet long, and half an inch broad. It is generally in a steep bank of bare clay, so that the wet may run off. The gallery is lined from top to bottom with a web of fine silk, which prevents the walls from falling in, and also gives notice to the spider of what is passing above.

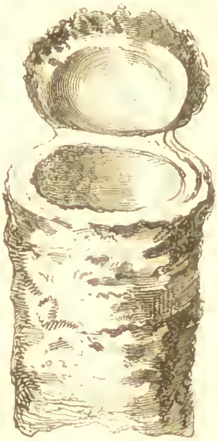


TRAP-DOOR SPIDER OF THE NATURAL SIZE.

But the most wonderful part is the entrance-door: this turns upon a well-made hinge, and falls together by its own weight. In shape this door is round; the under surface smooth and convex; the upper flat and rough, and scarcely to be distinguished from the clay of the bank. The thickness of this door is made up of alternate layers of dry earth and silk; the hinge is of silk, and so well constructed that the door can be opened and shut with the greatest ease: it is attached to the highest side of the opening, so that the door, when pushed up, shuts again by its own weight. Just within the entrance is a little edge or groove, upon which the door closes perfectly. If you attempt to force open this door by inserting the point of a pin under the edge, some resistance is made from within. This is occasioned by the spider itself; for the vibrations of the threads, which extend from the door to the bottom of her gallery, instantly inform her of the attempt made to force her dwelling. She therefore runs to the door, fastens her legs to it on one side, and on the other to the walls; and, turning upon her back, pulls with all her might. If the door is forced open, she escapes by flight; if it is fastened down from the outside, a new entrance with a new door will be formed in the course of a few hours; and if the door be entirely removed, a new one will soon be made to take its place.



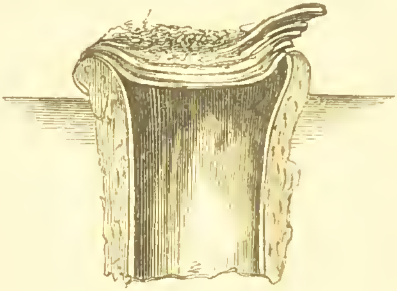
SIDE VIEW OF THE UPPER PORTION OF THE NEST, WITH THE TRAP-DOOR PARTLY OPEN.



FRONT VIEW OF THE SAME.

This habitation is not used as a snare, but simply as a dwelling-house. The family consists often of male and female, and as many as thirty young ones. They get food by hunting; and the remnants of many a meal, such as the hard parts of beetles, &c. cover the bottom of the gallery.

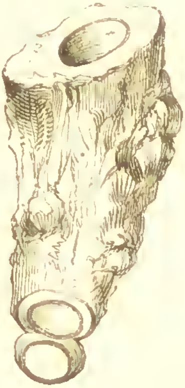
Mr. Saunders has described, in the Entomological Transactions, several of these nests, which, he says, are common in Ionia. They are found close round the roots of olive trees, in a somewhat elevated situation, and generally two or three together about the same tree. The upper portion of the nests is partially raised above the surface of the ground; but this may have arisen from the washing away of the surrounding earth during heavy rains. The trap-doors are all more or less provided with an elevation at the margin, directly above the hinge, to the extent in some instances of one-third of the diameter of the lid. The object of this projection could not be mistaken; for, acting as a lever, the slightest pressure upon it would suffice to raise the trap-door, and afford the readiest ingress to the spider. This elevation appears to be produced by a gradual lengthening in the direction of the hinge of the respective layers of which the lid is composed.



SECTION OF NEST AND TRAP-DOOR.

But there is a peculiarity in some of these nests which is calculated to excite the greatest surprise.

The extreme end within the ground is furnished with a second trap-door, smaller than the upper one, and opening downwards.



LOWER PORTION OF NEST, WITH THE SMALLER VALVE OPEN.

Mr. Saunders was at first inclined to think that this second trap-door was meant to act as a drain to the bottom of the nest, "for in no other way," he says, "can I account for the construction of these singular portals, in a situation where to all appearance they are destined to remain closed throughout the whole period of their existence." He therefore determined to put this opinion to the test of experiment. Having placed several nests, which were taken from the ground in October, and incased in some of their natural earth, within a small box, the top of which was closed with bars of wood, Mr. Saunders put this box out in a balcony, where it remained until the following April, when the spiders were all found alive and well. The upper portions of two of these nests, which broke in the process of extraction, were then placed in an open flower-pot, with a sufficient quantity of the same earth well moistened and compressed, so as to form a compact body in imitation of the soil itself. A third spider was placed in the same pot, with his tube in a *reversed* position, the lid being buried to the depth of about three inches, and the open part of the tube then broken off, being placed on a level with the surface in order that the insect might be tempted to adapt a new door to this part. Fearing, however, that the spider might escape, a strong paper stopper was fixed in the top of the tube. On the next morning this stopper was found lying aside, and the top of the tube closed with a single layer of web and earth, offering but slight resistance to the touch, although by no means transparent; the side destined for the hinge (as marked by the circumference being here interrupted by a straight line) being on a level with the surrounding earth, whereas at the opposite part, where the lid would open, the new cover was lowered about one quarter of an inch.

The danger of disturbing the occupant at this stage of the work prevented Mr. Saunders from opening the new lid; but in order to ascertain whether the next layer would be added from without or from within, the top was made white with flour. The next morning, however, it was found that the new door had been entirely cut away, and was lying by the side of the tube, which in the place thereof was now covered with a strong texture of whitish web. It remained in this condition for a week, when it occurred to Mr. Saunders that the spider had been compelled to discontinue its work, in consequence of the earth not being any longer sufficiently moist for the purpose ; and had therefore had recourse to the temporary expedient of closing its habitation in the way alluded to, until another opportunity, when, supposing the nest to be in its natural site in the open ground, the necessary moisture should have afforded the required facilities. The earth was, therefore, well watered without disturbing the web, allowing a slight sprinkling to fall thereon, as a sort of warning notice ; the next morning a new door was found perfectly formed, which having been marked with flour, as above, was observed to remain unaltered for ten days, when, considering the work finished, Mr. Saunders extracted the nest, which now presented a lid at each end, both revolving on their hinges, and complete in every respect.*

Mr. Saunders thinks this experiment throws some light on the existence of the lower trap-door. The nest being constantly exposed to the danger of becoming thus reversed in the process of opening the ground around the olive trees, (an operation annually performed,) the occupant in such cases might not improbably have recourse to a like expedient of closing the inverted tube with a new door. The circumstance of the lower door being smaller than the upper one would naturally occur in a nest so reversed, since the tubes are usually somewhat more spacious towards the bottom, so that when inverted and broken off, the new valve would of necessity be of greater dimensions than the original one.

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* This curious nest is to be seen in the Entomological Collection in the British Museum.

The skill and ingenuity connected with the perseverence of the spider are here very conspicuous; and may read a lesson to those who expect to succeed without giving their best attention to their work. It is not enough simply to go on, day after day, in the same round of employment, without caring whether it be well or ill performed. And yet too many are contented to act in this way. They go through their work in a careless, slovenly manner, and appear to be thinking of something else all the time. The frequent complaints of masters and mistresses show that this conduct is common among all classes of servants and workmen. The field labourer, the mechanic, and the household servant, alike neglect their duty, or perform it unfaithfully. There are some, indeed, who cannot be included in this blame. They are persevering and thoughtful persons, who are not too proud to learn, and who are daily studying to do *well* whatever they take in hand. Such persons find, that by giving their minds to their work, they soon discover the best way of doing it, so as to give satisfaction to their employers, and at the same time to lessen their own labour. Diligence and a good method of working, perform wonders, and yield a rich reward in the pleasure and contentment they bring with them. The precise and beautiful manner in which the spider works, so neatly lining her gallery with silk, and so wonderfully forming and carefully fixing her door and its hinges, may be remembered with advantage both by the persevering and skilful workman, as a curious example afforded to him ; and by the indolent and awkward servant, as a matter of reproach and shame, that he should be thus excelled by one of the lowest and most insignificant of creatures.

But if the habitation of the trap-door spider is wonderful, that of the water spider is still more so. As her name implies, she lives chiefly in the water, swimming about with great speed and dexterity ; sometimes on her belly, but more frequently on her back. She is an admirable diver, and will often

THE WATER SPIDER.

catch her prey on land, and plunge with it to the bottom of the water to make her meal.

But spiders, in general, have a great aversion to being wet; and the water spider avoids this inconvenience by a very wonderful contrivance. She carries down with her a chamber of air, in which she can live in comfort and security. The proceedings are thus described by Mr. Kirby:—"First she spins loose threads, in various directions attached to the leaves of aquatic plants, which may be called the framework of her chamber; and over them she spreads a transparent varnish, resembling liquid glass, which issues from the middle of her spinners, and which is so elastic that it is capable of great expansion and contraction; and if a hole be made in it, it immediately closes again. Next she spreads over her belly a pellicle of the same material, and ascends to the surface. The precise mode in which she transfers a bubble of air beneath this pellicle is not accurately known.

"Clothed with this aerial mantle, which to the spectator seems formed of resplendent quicksilver, she plunges to the bottom, and with as much dexterity as a chemist transfers gas with a gas holder, introduces her bubble of air beneath the roof prepared for its reception. This manœuvre she repeats ten or twelve times, until, at length, in about a quarter of an hour, she has transported as much air as suffices to expand her apartment to its intended extent, and now finds herself in possession of a little aerial edifice, I had almost said an enchanted palace, affording her a commodious and dry retreat in the very midst of the water. Here she reposes, unmoved by the storms that agitate the surface of the pool, and devours her prey at ease and in safety. Both sexes form these lodgings." This spider is one of the largest European species, and, in some countries, not uncommon in stagnant pools.

Shy and fearful as spiders generally are, yet they are not excluded from the list of animals that have been "tamed of mankind." (See James iii. 7.) Several instances have occurred in which the spider has proved itself sensible to kindness. Even the large hunting species, which usually inspire terror among the ignorant and superstitious, are capable of being tamed. There is a remarkable instance of this in the case of a very large species of spider called the Tarantula, described as being about the size of a chestnut. This spider is common near Taranto in Italy;* and the peasants of that country pretend that its bite is sometimes fatal, and always productive of great pain and danger to those who suffer from it. Women who go about gathering herbs with naked feet often get bitten by this spider, which burrows in the ground, and darts out suddenly on its prey. The truth is, that the bite produces nothing more than a slight inflammation of the part; but these peasants, in order to get money, have pretended, when bitten by it, to fall into a state of torpor or deep sleep, from which nothing could arouse them but some very lively tune, to the sound of which they arose and danced with wonderful energy, until the poison (as they said) had been worked out of the constitution. Even this large and fierce spider has been made so tame by being kept in confinement, and regularly fed, that it has come to take from the fingers of its keeper, the living flies that were brought as food. The history of this creature, as related by M. Leon Dufour, is so interesting that an abstract of it may not be considered out of place here.

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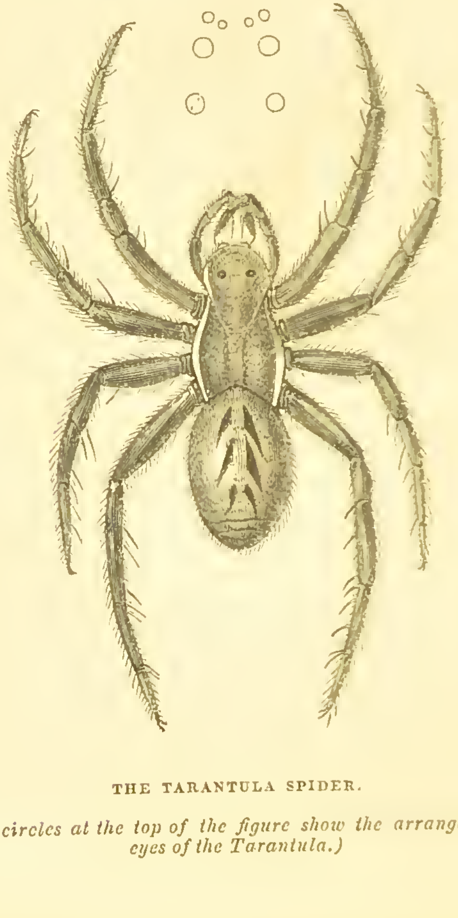
* It is also found in Spain and some other countries.

The tarantula prefers to dwell in dry, barren, uncultivated places, such as are exposed to the sun. It conceals itself in burrows which it digs for itself; these are cylindrical and often an inch in diameter, and are sunk more than a foot in the soil. The tarantula proves himself to be a skilful hunter as well as an able engineer. It was necessary not only that he should construct a deep entrenchment which might conceal him from the pursuit of his enemies; he must also establish there a place of observation from which he could spy out his prey and dart upon it. The tarantula has provided for all this. The burrow has first a vertical direction, but at four or five inches from the surface it turns so as to form a horizontal bend, and then again becomes upright. It is at the commencement of this bend that the vigilant sentinel places himself, and never, for a moment, loses sight of the door of his dwelling; and in that position his eyes may be seen glittering like diamonds from the gloomy cell. The outer opening of the burrow is commonly surrounded by a funnel, which rises about an inch above the surface of the soil, and is sometimes two inches in diameter. This piece of architecture is of great use at the moment when the animal is about to seize its prey. It is composed principally of fragments of dry wood, united by a little clay, and disposed one upon another in such an artist-like manner, that they form a scaffolding in the shape of a hollow upright column. It is lined with a tissue formed of threads spun by the animal, which is continued through the whole interior. It is easy to imagine how useful this tapestry lining must be in preventing the crumbling in of the earth, as well as assisting the animal to scale its fortress. This funnel also serves as an ambush by offering to this and other animals upon which the tarantula feeds an enticing resting place.

M. Dufour's account of the search after the Tarantula is amusing enough. The months of May and June are most favourable for the purpose. The first time that he discovered the holes of this spider, and was satisfied that they were inhabited by perceiving the lustre of his bright eyes, M. Dufour thought the best way to obtain possession of him would be to attack him by open force and follow him to the termination of his burrow.

"I passed whole hours opening the intrenchment with my knife, in order to sack his domicile. I dug to the depth of more than one foot over a space two feet in width without meeting with the Tarantula. I recommenced my operation in other holes, and always with as little success. I ought to have had a pick-axe to attain my end; but I was far from any house, and in Spain. I was then obliged to change my plan of attack, and I had recourse to stratagem. It occurred to me to take, by way of bait, a stalk surmounted by a spikelet, and to shake it and rub it gently against the opening of the hole. I was not long in perceiving that the attention and desire of the animal were awakened. Tempted by this lure, he advanced with a slow and irresolute step towards the spikelet, and upon my drawing it back a little out of the hole, in order to leave him



THE TARANTULA SPIDER.

(The small circles at the top of the figure show the arrangement of the eyes of the Tarantula.)

no time for reflection, he frequently used to throw himself at one spring out of his dwelling, the entrance of which I instantly closed. In this case the tarantula, greatly disconcerted to find himself unable to regain his domicile, was very awkward in his attempts to elude my pursuit, and I obliged him to take up his quarters in a piece of paper, in which I instantly shut him up.

"It sometimes happened that, suspecting the snare, or perhaps less pressed by hunger, he held back immovable, at a little distance from his door, which he did not judge it advisable to pass, until my patience was completely exhausted. When this occurred, these are the tactics I made use of:—after having well observed the direction of the hole and the position of the spider, I forcibly drove in the blade of my knife in an oblique direction, so as to stop up the hole and prevent the retreat of the creature. In this situation the terrified animal either quitted his retreat or remained close up against the blade of the knife. Upon this, causing the knife to make a sudden sweep, I threw out both the earth and the spider, and seized upon the latter. By employing this method of capture, I sometimes took as many as fifteen tarantulas in an hour. In some circumstances when the tarantula was quite aware of the deceit which I was practising, I have been not a little surprised, on my pushing in the spikelet so as even to touch him in his den, to see him play with it with a sort of contempt, and push it back with his claws without giving himself the trouble to seek the further end of his retreat."

The tarantula, frightful as it is at first sight, especially when one is impressed with the idea of danger from its bite, and shy as it appears, is yet very capable of being tamed. M. Dufour relates the history of a tarantula, which he kept alive for more than five months. "On the 7th May, 1812, during my stay at Valencia in Spain, I took, without hurting him, a tarantula of tolerable size, which I imprisoned in a glass covered over with paper, in which I had made a square opening. In the bottom of the glass I had fixed the roll of paper in which I had carried him, and which was to serve him for a dwelling. I placed the glass upon a table in my sleeping-room, that I might have frequent opportunities of watching him. He quickly accustomed himself to his cell, and at length became so familiar that he would come to eat out of my fingers the living fly that I brought him. After having given his victim its death-wound with his jaws, he did not content himself, like most spiders, with sucking the head, but bruised all its body by plunging it successively into his mouth with his feelers. He then threw away the remains, and swept them to a distance from his hiding-place. After his repast, he seldom omitted attending to his toilet, which consisted in brushing with the tarsi of his fore-legs his feelers and mandibles, without as well as within; and having done this, he resumed his attitude of immovable gravity. The evening and night were his times of walking and attempting to escape. I often heard him scratching against the paper of his prison. These nocturnal habits confirmed my opinion that the greater number of spiders can distinguish objects by night as well as by day. At the end of June my tarantula changed his skin; and this moult, which was the last, did not sensibly alter either the colour of his covering or the size of his body."

On two occasions, in July and August, M. Dufour was absent during nine days each time; but this long fast does not seem to have injured the health of his captive. In October he again left the spider without any provision, but afterwards sent his servant for it, but it had disappeared and was heard of no more.

There are instances where the net-weaving spiders have been found equally tractable. A Frenchman named Pelisson, imprisoned in the Bastile, with no other means of amusement than that afforded by a musical instrument, observed a spider making its web at the edge of the window which lighted the prison. To relieve the dreadful wearisomeness of his situation he undertook to tame it, and this he accomplished by placing flies in its way, and summoning the animal to its feast by musical sounds. By degrees the spider became accustomed to the sound, and ran from its hole to receive its prey. Thus, by being always summoned by the same sound, and having its food placed gradually at a farther distance from the web, the creature in a few months became so well disciplined, that at the first signal it would leave its hiding-place, and come and take its flies at the bottom of the chamber, under Pelisson's eyes.

"Come what will,
The generous man has his companion still;
The cricket on his hearth; the buzzing fly,
That skims his roof, or, be his roof the sky,
Still with its note of gladness passes by.
And in an iron cage condemned to dwell,
The cage that stands within the dungeon-cell,
He feeds his spider—happier at the worst
Than he at large who in himself is curst?"

While we consider the power of kindness to tame and win over the most refractory or the most timid creatures which come beneath the sway of man, let us also remember the wonderful power of kindness in healing divisions, softening bad tempers, and removing discord among human beings. How true it is that "a soft answer turneth away wrath, but grievous words stir up anger!" (Prov. xv. 1.) Many a quarrel might be avoided, if people could only be persuaded to give the "soft answer" instead of the "grievous words." Suppose a man to be unjustly accused, how much more likely is he to clear himself, by quietly stating the truth, and giving a plain and sober explanation of his conduct, than by falling into a passion, and using reproachful and bitter words. The world would soon bear a very different appearance, if each one would learn to bridle his tongue. Nothing, however, but divine grace can enable a person to do this; for, in order to bridle the tongue, we must bridle all those unruly passions which find utterance in speech. "Every kind of beasts, and of birds, and of serpents, and of things in the sea, is tamed, and hath been tamed of mankind: but the tongue can no man tame; it is an unruly evil, full of deadly poison. Therewith less we God, even the Father; and therewith curse we men, which are made after the similitude of God. Out of the same mouth proceedeth blessing and cursing. My brethren, these things ought not so to be." (James iii. 7—10.) But if it is not in the power of any human being, unaided by God, to overcome the sins of the tongue, yet we have the most gracious assurances of divine help, in our hearty endeavours to do so. Perseverance in prayer, and perseverance in watchfulness, will certainly be attended with a blessing, for our Redeemer has himself assured us that if we ask anything in His name, He will do it (John xiv. 14); and has also declared, that "Blessed are those servants whom the Lord when he cometh shall find watching." (Luke xii. 37.)

In concluding this series, the writer wishes to observe, that although so much space has been occupied with the history of insects, the reader will not consider the study of insects frivolous, although the objects of it are small. M. Réaumur (who passed much of the leisure of a useful and active life in the study of insects, and has filled six large quarto volumes with original observations thereon,) is willing "that these pursuits should be regarded as amusements; that is, as studies which, so far from being laborious, afford pleasure to him who engages in them. But," he adds, "they do more,—they necessarily raise the mind to admire the Author of so many wonders. Ought we to be ashamed of ranking among our occupations, observations and researches of which the object is an acquaintance with the works on which the Supreme Being has displayed such boundless wisdom, and so great a degree of variety? Natural history is the history of His works, and as such is a demonstration of His existence intelligible to all mankind."